Hill Air Force Base, Utah

Final

Engineering Evaluation/Cost Analysis for Operable Unit 12

April 2004

HILL AIR FORCE BASE, UTAH

FINAL

ENGINEERING EVALUATION/COST ANALYSIS
OPERABLE UNIT 12

APRIL 2004

Project No. 1970977.07010423

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LIST OF ACRONYMS

°F	degrees Fahrenheit
μg/l	micrograms per liter
μg/kg	micrograms per kilogram
AADA	Aspen Avenue Disposal Area
ARARs	applicable or relevant and appropriate requirements
AS	air sparging
bgs	below ground surface
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	centimeters per second
CPT	cone penetration testing
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
ft/ft	feet per foot
gpm	gallons per minute
HCS	Hydraulic Containment System
HDPE	High-Density Polyethylene
Hill AFB	Hill Air Force Base
IRP	Installation Restoration Program
IWTP	Industrial Wastewater Treatment Plant
MALs	mitigation action levels
MAMS	Missile Assembly, Maintenance, and Storage
MAP	Management Action Plan
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mph	miles per hour
MWH	MWH Americas, Inc.
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDCSD	North Davis County Sewer District
NGVD	National Geodetic Vertical Datum
NPL	National Priorities List
O&M	operation and maintenance
OU	Operable Unit

LIST OF ACRONYMS
(continued)

ppb	parts per billion
PCE	tetrachloroethene
POTW	publicly owned treatment works
PRB	permeable reactive barrier
PRSC	post-removal site control
PVC	poly-vinyl chloride
RAOs	removal action objectives
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
TCE	trichloroethene
tsf	tons per square feet
UDEQ	Utah Department of Environmental Quality
USAF	United States Air Force
UTA	Utah Transit Authority
VOCs	volatile organic compounds
ZVI	zero valent iron

EXECUTIVE SUMMARY

Operable Unit (OU) 12, located in the northwest portion of Hill Air Force Base (Hill AFB), Utah, consists of contaminated soil and groundwater at the on-Base Aspen Avenue Disposal Area (AADA) and contaminated groundwater located off Base beneath the City of Roy and the extreme northeast portion of the City of Sunset. The primary contaminants in groundwater at OU 12 are volatile organic compounds (VOCs), of which the most widespread contaminant detected above its maximum contaminant level (MCL, 5 micrograms per liter [μg/l]) is trichloroethene (TCE). Hill AFB has implemented an early action at OU 12 in an effort to reduce migration of contaminants in groundwater to off-Base areas (i.e., OU 12 Base Boundary Hydraulic Containment System installed as a treatability study) and implemented several time-critical removal actions to minimize exposure to contaminants in indoor air in residences overlying the off-Base groundwater plume (i.e., indoor air mitigation systems installed through a Base-wide program). Hill AFB is proposing an additional early action to address the further downgradient migration of the OU 12 off-Base contaminant plume. The objective of this Engineering Evaluation/Cost Analysis (EE/CA) is to evaluate alternatives for a non-time-critical removal action that would reduce the potential for further downgradient degradation of groundwater quality while minimizing impacts to the community.

The removal action proposed in this EE/CA will be located in the OU 12 off-Base groundwater plume at the railroad corridor property situated between 2700 West and 2775 West in the City of Roy. Construction of a removal action on this property minimizes impacts to the community in terms of residents affected, constructability, and cost.

The alternatives evaluated in this EE/CA include:

Alternative 1 - Aeration Curtain. The aeration curtain employs the principles of air sparging (AS) and soil vapor extraction (SVE) technologies to provide groundwater treatment of VOCs. A series of pipes installed inside a subsurface trench blow air through contaminated groundwater, creating a curtain of bubbles that volatilize the VOCs from groundwater into the vadose zone. A vapor extraction system located in the vadose zone then captures the contaminant vapors from the soil for further treatment and disposal.

Alternative 2 - Slurry Wall and Extraction Trench. The combination of a slurry wall and an extraction trench is designed to capture and extract shallow contaminated groundwater while reducing water table drawdown to minimize settlement-induced stresses on the nearby structures. A gravel-filled groundwater extraction trench would be installed for hydraulic gradient control and collection of contaminated groundwater, which would be discharged to the local publicly owned treatment works (POTW) for treatment and final disposal. A slurry wall of equal length would be installed parallel to and downgradient of the extraction trench to provide for containment of the contaminant plume and reduce the drawdown required to achieve capture.

Alternative 3 – Permeable Reactive Barrier (PRB) Wall. A PRB wall constructed of a granular zero valent iron (ZVI) and sand mixture, would allow contaminated groundwater to pass through the barrier where contaminants would be chemically transformed to a less toxic state.

For comparison in this EE/CA, each of the systems is designed to intersect the width of the OU 12 TCE plume as defined by the MCL at the railroad corridor.

The National Contingency Plan (NCP) Section 300.415 (i) requires that removal actions attain or exceed State and Federal applicable or relevant and appropriate requirements (ARARs) to the maximum extent practicable, considering the constraints of the situation. The site-specific factors that justify a non-time-critical removal at OU 12 include:

1) The OU 12 groundwater plume is not believed to be stable and will continue to migrate downgradient resulting in further groundwater degradation. The contaminated groundwater has the potential to emerge into residential basements due to shallow groundwater conditions that exist in this area.

2) VOCs found in the groundwater plume also have been detected in indoor air at several residences at concentrations exceeding their respective mitigation action levels (MALs). Although indoor air mitigation systems have been installed at these locations to address the contamination in the residence, the systems do not address the cause of the problem in groundwater or prevent the groundwater contamination from migrating further downgradient and potentially resulting in further indoor air problems.

The scope of the removal action proposed in this document is intended to provide stabilization of the TCE plume until the final site remedy can be implemented. Removal action objectives (RAOs) developed to meet the scope include the following:

- To reduce the potential for further downgradient degradation of groundwater quality by preventing the uncontrolled movement of the existing plume

- To reduce the potential for further degradation of indoor air contamination that can be attributed to the OU 12 groundwater contaminant plume

- To minimize impacts to the community during remedy construction and operation.

The goals of these RAOs are to: 1) reduce concentrations in groundwater to less than their MCLs at the downgradient performance monitoring points, and 2) be consistent with any existing and future remedial activities.

Each of the proposed removal action alternatives is evaluated with respect to short-term and long-term aspects of three critical criteria, which are effectiveness, implementability, and cost, as described below.

Effectiveness. All three alternatives comply fully with the effectiveness criteria. They also comply fully with long-term effectiveness and permanence and reduction of toxicity, mobility, or volume through treatment criteria. However, the PRB Wall (Alternative 3) is considered superior to the other two alternatives in that it achieves reduction of toxicity without any disruption to natural groundwater flow or loss of resource. The Slurry Wall and Extraction Trench (Alternative 2) requires that groundwater be extracted and treated at the POTW. The groundwater is therefore lost for beneficial use. The Aeration Curtain (Alternative 1) achieves reduction in toxicity by transferring the contaminants from groundwater to the vadose zone for subsequent extraction and discharge to the atmosphere, but may have noise considerations in a residential neighborhood. With respect to short-term effectiveness, all three alternatives only partially meet the criteria due to the probability of risk, however minimal, to community, workers, and the environment during the implementation stage of the alternatives.

Implementability. Only the Slurry Wall with Extraction Trench (Alternative 2) and the PRB Wall (Alternative 3) comply fully with the implementability criteria. Due to the complexity involved in construction of the Aeration Curtain (Alternative 1), it only partially meets the criteria in comparison to the other two alternatives. This could result in additional time on site disrupting residences compared to the other alternatives. The Slurry Wall and Extraction Trench option requires two trenches in which the Slurry Wall would be located at the approximate center line of the property. This may pose a settlement concern in the future if the railroad becomes active again. The PRB Wall is considered more advantageous than the two other alternatives because the site can be easily restored to original conditions allowing for subsequent use of the property with minimum surface disruptions (such as monitoring wells and trench markers). For these reasons the PRB Wall also complies with RAO #3 better than the other two alternatives.

Cost. Alternative 1 is most expensive with a total direct cost of $2,289,841 (-30%/+50%) and a 30-year present worth of $6,271,000 (-30%/+50%). Alternative 2 is the second most expensive with a total direct cost of $1,497,702 (-30%/+50%) and a 30-year present worth of $4,070,000 (-30%/+50%). Alternative 3 is the least costly alternative with a total direct cost of $1,529,958 (-30%/+50%) and a 30-year present worth of $2,356,000 (-30%/+50%). The main difference in 30-year present worth costs is related to annual operation and maintenance costs of each system.

State and Community Acceptance. Because the State and the local community have yet to be apprised of the proposed removal action at the railroad corridor site in the form of the Action Memorandum, the State and community acceptance criteria are undetermined at the present time.

Recommended Removal Action Alternative. Based on the detailed and comparative analysis of the three proposed alternatives, Alternative 3 (the PRB Wall) was selected as the recommended alternative. The following reasons were critical in making this determination:

- Alternative 3 presents the remedy to achieve all the RAOs most effectively.

- Construction of Alternative 3 is expected to require the least amount of time during which the community, site workers, and the environment may be exposed to minimal risks and disruptions thereby measuring compliance with RAO #3.

- Once implemented, Alternative 3 would require the least attention in maintaining and operating the system.

- Once implemented, the project site could be restored to its original state with minimum features left above ground (such as monitoring well points). Hence the inactive railroad could also be activated, if required, at a future date with minimal to no impacts to either site use or system operation.

- Due to the passive nature of the PRB Wall, no discharges or wastes are generated during the operation of the system that would require disposal.

- Although the direct capital costs of the PRB Wall are higher than that of Alternative 2 (the combination extraction trench and slurry wall), substantial cost savings are seen in the lower O&M costs for the PRB Wall making it the most economical of the considered remedies.

1.0 INTRODUCTION

1.1 BACKGROUND

1.1.0.1. Hill Air Force Base (Hill AFB) was placed on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; the Superfund Program) in July of 1987. Operable Unit (OU) 12, located in the northwest portion of Hill AFB, is one of twelve operable units that have been identified at Hill AFB (See Figure 1-1). OU 12 consists of contaminated soil and groundwater at the on-Base Aspen Avenue Disposal Area and contaminated groundwater located off Base beneath the City of Roy and the extreme northeast portion of the City of Sunset. Additional information concerning OU 12 is provided in the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a).

1.1.0.2. Groundwater Contamination. The primary contaminants in groundwater at OU 12 are volatile organic compounds (VOCs). The most widespread contaminant detected above its maximum contaminant level (MCL) at OU 12 is trichloroethene (TCE). As defined by its MCL of 5 micrograms per liter (μg/l [equivalent to 5 parts per billion (ppb)]), the OU 12 TCE plume is estimated to encompass 623 million gallons of contaminated groundwater, and extends approximately 8,500 feet from the source area on Base to the leading edge of the plume beneath the City of Roy, underlying a land surface area of 126 acres (see Figure 1-1).

1.1.0.3. Early Actions at OU 12. Hill AFB has implemented an early action at OU 12 in an effort to reduce migration of contaminants in groundwater and implemented several time-critical removal actions to minimize exposure to contaminants in indoor air in residences overlying or near the plume. The first early action at OU 12 is the Base Boundary Hydraulic Containment System (HCS), consisting of an array of three extraction wells installed along the Base boundary where the contaminant plume leaves the Base (see Figure 1-1). The objective of this system was to capture contaminated groundwater associated with the OU 12 source area and prevent further migration of contaminants from the on-Base source area to off-Base areas. Installed as a treatability study, the system allows Hill AFB to investigate means of mitigating or eliminating the source of the plume on Base while preventing contaminated groundwater from moving off Base. The OU 12 Base Boundary Hydraulic Containment System, began operation in April 2003. Other early remedial actions that were undertaken as time-critical removal actions include installation of indoor air mitigation systems at nine residences. The indoor air mitigation systems were installed to reduce or eliminate the contamination in indoor air caused by vapor migration from the contaminated shallow groundwater into soil and indoor air in accordance with the *Final Action Memorandum for Time-Critical Removal Actions for Indoor Air* (MWH, 2003b). The indoor air mitigation program is a Base-wide program.

1.2 PURPOSE

1.2.0.1. As part of these ongoing efforts towards early remedial actions, Hill AFB is proposing a removal action to address the further downgradient migration of the OU 12 off-Base contaminant plume. The objective of this Engineering Evaluation/Cost Analysis (EE/CA) is to evaluate alternatives for a non-time-critical removal action that would reduce the potential for further downgradient degradation of groundwater quality while minimizing impacts to the community.

1.2.0.2. The removal action proposed in this EE/CA will include a groundwater containment system to be located in the OU 12 off-Base groundwater plume at the railroad corridor property situated approximately midway between 2700 West and 2775 West in the City of Roy (see Figure 1-1). This property was historically used by the Denver and Rio Grande Railroad; currently this property is owned by the Utah Transit Authority (UTA) and the railway is not in use. Construction of a removal action on this property minimizes impacts to the community in terms of residents affected, constructability, and cost. Other sites considered include locating the plume containment system in the street at 2700 West, in the backyards of properties on the west side of 2700 West, or in the street at 2775 West. These were eliminated from further consideration due to increased impacts to the community, constructability and site access issues, and cost.

1.2.0.3. The alternatives that will be evaluated in this EE/CA include:

Alternative 1 - Aeration Curtain

Alternative 2 - Slurry Wall and Extraction Trench

Alternative 3 - Permeable Reactive Barrier (PRB) Wall.

For comparison in this EE/CA, each of the systems is designed to intersect the width of the OU 12 TCE plume as defined by the MCL at the railroad corridor.

1.3 DOCUMENT ORGANIZATION

1.3.0.1. In addition to this introduction, the EE/CA is organized in the following sections:

- Section 2 provides a summary of site characteristics including site geology, hydrogeology, contaminant source, and nature of contamination. Section 2 also contains a summary of the baseline risk assessment (BRA) presented in the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a).

- Section 3 identifies the proposed removal action objectives such as scope, schedule, and statutory limits.

- Section 4 describes the three alternatives proposed and analyzes the alternatives for EE/CA criteria such as effectiveness, implementability, and cost.

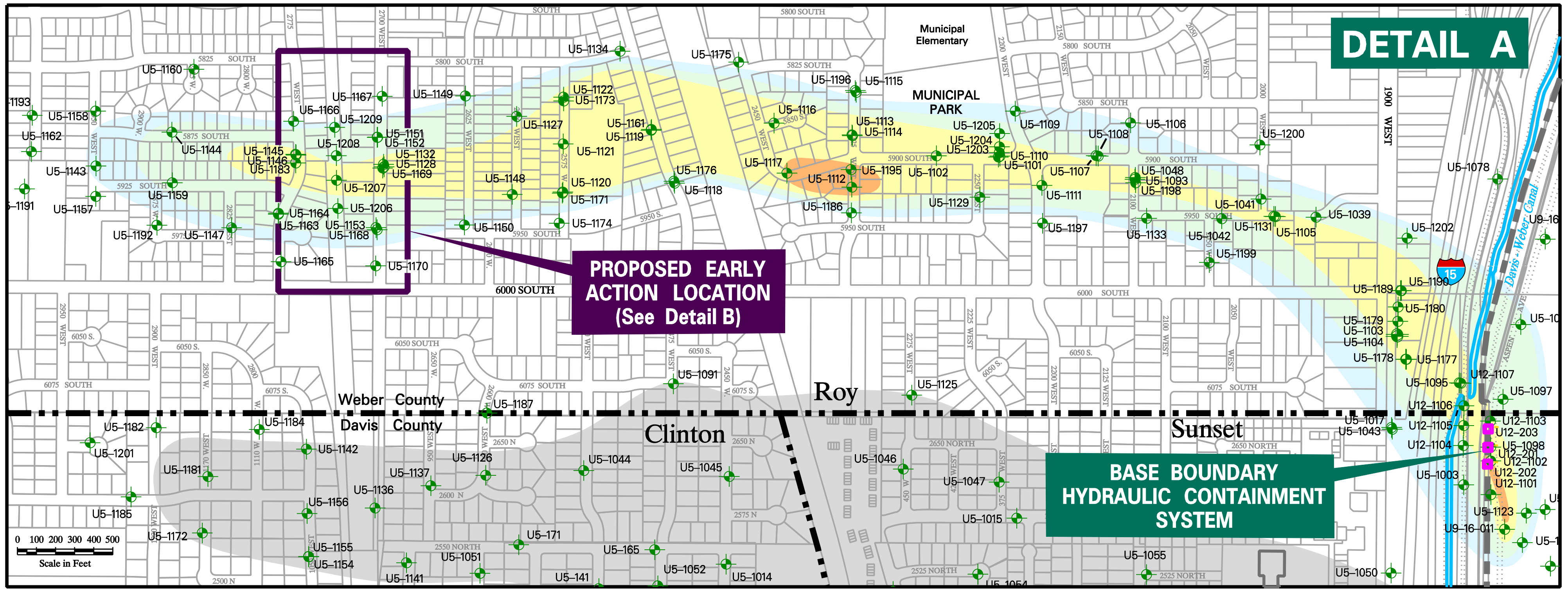
- Section 5 presents a comparative analysis of the three alternatives with respect to the EE/CA objectives and describes the recommended alternative resulting from the EE/CA.

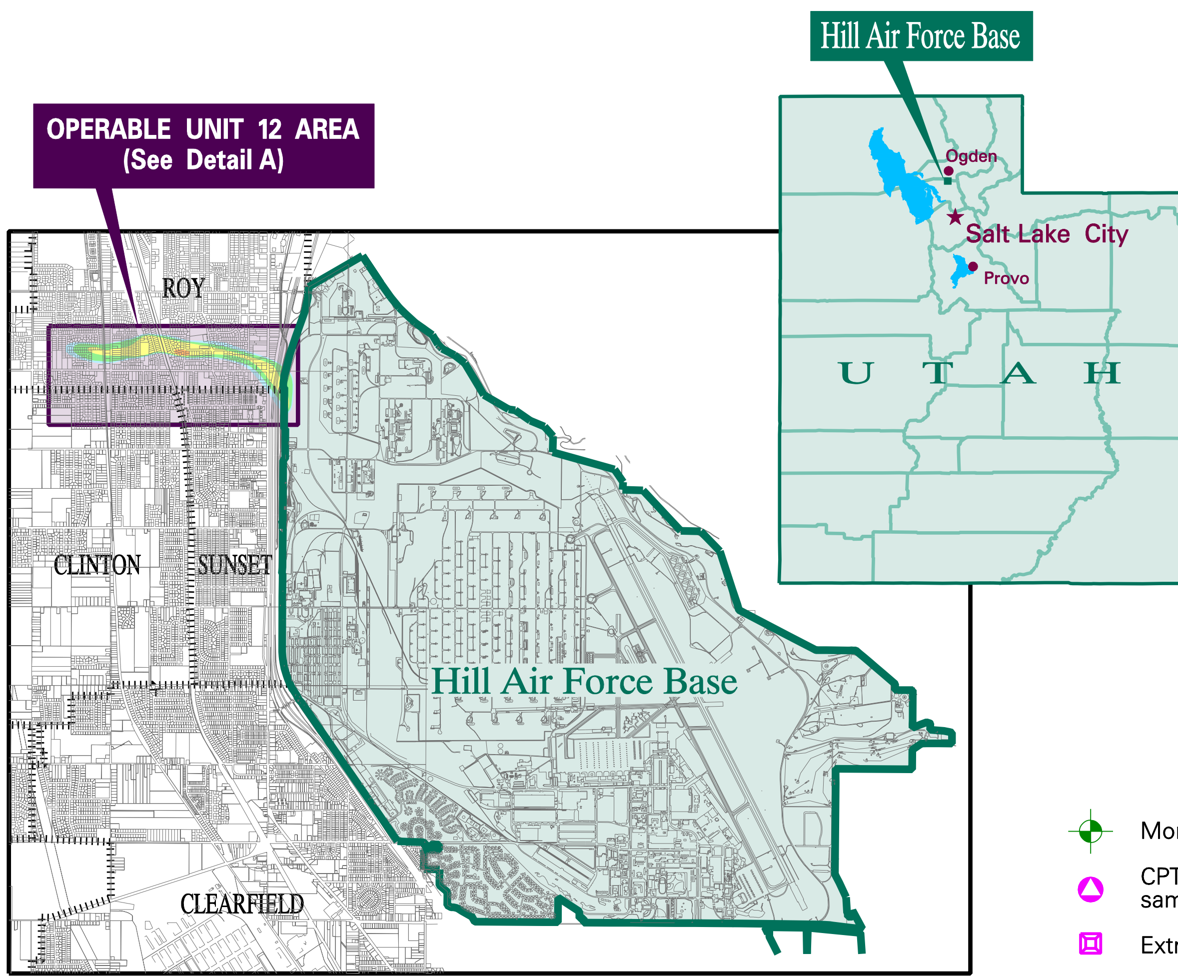
Additional information in support of the EE/CA is provided in the following appendices:

- Appendix A documents the groundwater flow and contaminant transport modeling that was performed to assist with the EE/CA.

- Appendix B presents detailed descriptions of the applicable or relevant and appropriate requirements (ARARs) pertinent to the proposed removal actions.

- Appendix C contains a breakdown of the cost estimates for each of the alternatives and backup information utilized in these cost estimates.





Proposed Early Action Location Along Railroad Corridor
Looking North

EXPLANATION

- Monitoring well
- CPT – direct push sampling location
- Extraction well
- ug/l Micrograms per liter

TRICHLOROETHENE (TCE) CONCENTRATIONS

5–10 ug/l	100–1000 ug/l
10–100 ug/l	1000–1500 ug/l

HILL AIR FORCE BASE
OPERABLE UNIT 12

VICINITY MAP, SITE MAP, AND PROPOSED EARLY ACTION LOCATION MAP

FIGURE 1–1

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2.0 SITE CHARACTERIZATION

2.1 SITE LOCATION AND BACKGROUND

2.1.1 Hill Air Force Base

2.1.1.1. Hill AFB is located in northern Utah, approximately 25 miles north of Salt Lake City and five miles south of Ogden, as shown in Figure 1-1. The majority of Hill AFB is located within northern Davis County, and a small portion of the Base extends into southern Weber County. Hill AFB is situated east of the Great Salt Lake and immediately west of the Wasatch Mountain Range. Hill AFB covers approximately 6,700 acres and is located on a delta terrace south of and approximately 300 feet above the Weber River Valley floor. The delta surface has slight to moderate relief with elevations varying from approximately 4,600 feet above the National Geodetic Vertical Datum (NGVD) along the western boundary of Hill AFB to 5,045 feet above NGVD along the eastern boundary. In contrast, the Wasatch Mountains, approximately four miles to the east, rise abruptly from the valley floor to an elevation of over 9,500 feet. The OU 12 area slopes to the west with elevations ranging from 4,620 feet on Base near the Missile Assembly, Maintenance, and Storage (MAMS)-II area to 4,360 feet off Base at the toe of the OU 12 plume. The Great Salt Lake, approximately 12 miles west of Hill AFB, is at an elevation of approximately 4,200 feet.

2.1.1.2. Former occupants of the site now referred to as Hill AFB included the Ogden Arsenal and the Ogden Air Depot. The Ogden Arsenal was located in the western portion of Hill AFB, and was activated in 1920 as an Army Reserve depot. The Ogden Air Depot commenced operations in 1940 in the southeastern portion of the Base and was known as the Rocky Mountain Air Depot. In 1948, following the creation of the United States Air Force (USAF) as a separate military service, the Rocky Mountain Air Depot was officially renamed Hill Air Force Base. In 1955, Ogden Arsenal was transferred from the U.S. Army Reserves to the USAF.

2.1.1.3. A variety of ongoing industrial operations support the missions of Hill AFB, including metal plating, degreasing, paint stripping, painting, sanding, and other operations associated with aircraft, missile, vehicle, and railroad engine repair and maintenance. These industrial operations used or generated numerous chemicals and wastes including chlorinated and non-chlorinated solvents and degreasers, petroleum hydrocarbons, acids, bases, metals, and other chemicals. These chemicals and their associated waste products historically were disposed of at the Industrial Wastewater Treatment Plant (IWTP), chemical disposal pits, landfills on the Base, or at other Air Force facilities. The *Environmental Restoration Management Action Plan* (MAP) (MWH, 2002a) presents a summary of the historical operations conducted at Hill AFB and wastes associated with those activities.

2.1.1.4. As far back as the 1970s, Hill AFB has made compliance with applicable environmental regulations a priority in its Base operations. In recent years, compliance with newly promulgated state and federal regulations has resulted in the elimination, reduction, and improved treatment/storage/disposal of hazardous materials on Base and off Base. Hazardous wastes currently generated at Hill AFB are disposed of according to the requirements of the Resource Conservation and Recovery Act of 1976 (RCRA). Since 1984, the USAF has committed significant resources to assess and remediate the environmental contamination identified at Hill AFB as a result of historic waste management practices. Hill AFB was already engaged in the Installation Restoration Program (IRP) when it was placed on the U.S. Environmental Protection Agency (EPA)'s NPL in July of 1987.

2.1.1.5. As part of the CERCLA's remedial investigation/feasibility study (RI/FS) process, 12 operable units have been designated at Hill AFB. Early Operable Units (i.e., OUs 1 through 7) were originally organized solely on the basis of geographic location. Later additions and revisions resulted in the designation of some operable units based upon the type of contaminated medium (i.e., OUs 3 and 8). OU 12 was the latest operable unit to be designated and is described below.

2.1.2 Operable Unit 12

2.1.2.1. Located in the northwest region of Hill AFB, OU 12 consists of contaminated soil and groundwater at the on-Base Aspen Avenue Disposal Area (AADA) and contaminated groundwater located off Base beneath the City of Roy and the extreme northeast portion of the City of Sunset (see Figure 1-1). Initially, OU 12 was investigated as part of OU 5 until it was established as its own operable unit in 2001.

2.1.2.2. Based on a search of historical records presented in the *Final Operable Unit 5 and 12 Historic Site and Source Area Review* (MWH, 2002b), the OU 12 area of the Base has not had significant use through time. A former Wastewater Treatment Plant (also known as the Sewage Disposal Plant) was under construction in 1941-42. The plant layout and sanitary sewer-piping maps indicate that the Wastewater Treatment Plant received wastewater from the entire north area of the Base until at least 1945, during the peak of its operations. All waste entering the sewer collection system in the north area facilities of the Base during the early to middle 1940s would have most likely passed directly to the former Wastewater Treatment, sludge drying beds, and tile and drain field area. It is unknown exactly when operation of the former Wastewater Treatment Plant was discontinued.

2.1.2.3. Immediately north-northwest of the former Wastewater Treatment Plant is the area informally named the AADA (see Figure 2-1). Records concerning disposal activities at the AADA have not been located. However, construction debris, bricks, clay pipes, drums and other debris are exposed at the ground surface in this area. Investigations in the area have identified buried drums and a tar-like material containing TCE. A more detailed description of the AADA is provided in Section 2.5.

2.1.2.4. The most prevalent contaminant in groundwater at OU 12 above its MCL is TCE. Other VOCs detected above MCLs at OU 12 include tetrachloroethene (PCE) and carbon tetrachloride. The primary source of the TCE appears to be the AADA, while the source of the carbon tetrachloride may be associated with the former Wastewater Treatment Plant. PCE does not appear to be related to sources at Hill AFB. A more detailed description of groundwater contamination at OU 12 is provided in Section 2.6.

2.1.3 Description of the Proposed Removal Action Site

2.1.3.1. The removal action proposed in this EE/CA will include a groundwater containment system that will be located off Base at the railroad corridor property located between 2700 West and 2775 West in the City of Roy. The railroad corridor is currently unused and tracks in the section that would be affected by the proposed action have already been removed. Railroad ballast remains as does a 4- to 10-foot-high fill mound used to build up the track elevation to the required grade. The railroad property is 100 feet wide at southern end adjacent to 6000 South, narrowing to 66 feet wide to the north. The property is vegetated with grasses, Russian Olives, Austrian Pines, and willows along the property boundaries. Based on data collected along 2700 West and 2775 West, the dissolved-phase TCE plume, as defined by the MCL for TCE (5 μg/l) is approximately 660 feet wide and extends to a depth of 30 feet below ground surface (bgs) where it crosses the railroad corridor property. The maximum TCE concentration in the area is approximately 200 μg/l.

2.2 SUMMARY OF SITE INVESTIGATIONS

2.2.0.1. Remedial investigations conducted in 1998 as part of the OU 9 North Area Site Inspection (SI) identified the existence of a previously undiscovered contaminant plume. As a result, additional RI work was initiated as described in the *Remedial Investigation/Feasibility Study Work Plans for Operable Units 5 and 9* (Montgomery Watson, 2000). Remedial investigation work at OU 12 was initially conducted as part of OU 5 investigations until the OU 12 plume was identified as separate and distinct from the OU 5 plumes. OU 12 was established as its own operable unit in 2001. A summary of remedial investigations and work performed at OU 12 is presented in the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a). Tasks performed include a historic site review, cone penetration testing (CPT) and direct-push groundwater sampling, monitoring well installation, groundwater sampling, water level measurements, in-situ permeability testing, aquifer testing, surface soil sampling, a soil gas survey, geophysical investigations (electromagnetic survey and ground penetrating radar), soil borings, soil sampling at depth with CPT wire-line, residential sampling (indoor air, soil, and water), a residential survey, an edible plant TCE uptake study, and groundwater flow and contaminant transport modeling. Investigation to better characterize contamination in the source area is ongoing.

2.3 SUMMARY OF HYDROLOGY

2.3.1 Climate

2.3.1.1. The climate of the Hill AFB area is temperate and semi-arid. The mean monthly temperatures are lowest in January, when the mean maximum temperature is 33 degrees Fahrenheit (°F) and the mean minimum temperature is 22 °F. The hottest month is July, when temperatures range between a mean maximum and minimum of 87 °F and 65 °F. The average annual precipitation during the period from 1980 to 1999 was 15.12 inches per year. The majority of precipitation falls from October through May. April is usually the wettest month, and July through August is the driest period. Pan evaporation is approximately 45 inches per year (Feth et al., 1966). The primary wind direction is from the east-southeast. Approximately 32 percent of the time the wind blows from that direction, and about two-thirds of that time the wind velocities are between 10 and 15 miles per hour (mph).

2.3.2 Surface Water Hydrology

2.3.2.1. The natural drainage pattern at Hill AFB has been altered through development of the Base. Much of Hill AFB surface flow is now diverted into a variety of ponds and ditches. Surface-water runoff from the western portion of the Base in the OU 12 area is diverted toward an active holding pond (Pond 11). The Davis-Weber Canal flows along the northern and western boundaries of the Base and is concrete lined along the portion that crosses OU 12. Since 1972, the Davis-Weber Canal has been in operation only during the irrigation season, from approximately April 15 to October 15. The depth to groundwater is approximately 60 feet bgs where the Davis-Weber Canal crosses the OU 12 contaminant plume. Farmers throughout the Roy area installed field drains in the early- to mid-1900s to redistribute water for irrigation and to remove the shallow groundwater, thus making the land more suitable for agriculture. Field drains were also installed to dewater areas for residential development. However, the locations of field drains within the City of Roy are not known, as their locations were poorly documented or not documented at the time of installation. Subsequent development of agricultural land into residential and commercial property over the last century has further removed or redirected unknown numbers of these field drains.

2.4 SUMMARY OF SITE GEOLOGY AND HYDROGEOLOGY

2.4.1 Regional Geology and Hydrogeology

2.4.1.1. The regional geology of the area is characteristic of a horst and graben structure created by normal faulting associated with the formation of the Basin and Range physiographic province. Alluvial and lacustrine basin-fill sedimentary depositional processes typify the grabens, while bedrock erosion is the dominant process taking place on the horsts (USGS, 1988). Hill AFB is situated east of the Great Salt Lake and immediately west of the Wasatch Mountain Range on the Weber River Delta that was associated with former Lake Bonneville. The nature of the sedimentary deposits underlying the Hill AFB area has been greatly influenced by former Lake Bonneville, the largest lake formed in the Basin and Range physiographic province during the Pleistocene Epoch (from 2 million to 10,000 years ago).

2.4.1.2. Two principal aquifers exist in the Hill AFB area: the Sunset and Delta aquifers. These aquifers are used for water supply in the area and are confined. Drillers logs from wells in the Hill AFB area indicate that several hundred feet of clay separate the shallow unconfined aquifers from these deeper water supply aquifers. More detailed descriptions of the regional geology and hydrogeology are provided in the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a).

2.4.2 Geology and Hydrogeology of Operable Unit 12

2.4.2.1. Stratigraphy. The stratigraphy of the shallow aquifer system has been characterized from lithologic and hydrogeologic data compiled from CPT, soil borings, and monitoring wells installed in the vicinity of OU 12. The following discussion is limited to the upper portion of the shallow aquifer where groundwater contamination is found. The subsurface stratigraphy in OU 12 consists of interbedded and laterally discontinuous silty sand, sandy silt, silt, and clay. In general, the shallow unconfined aquifer consists of silty fine-grained sand interbedded with silt. A low-permeability clayey silt unit underlies the shallow unconfined aquifer, below which no contamination from OU 12 has been detected. The low-permeability unit is defined by CPT logs having a high dynamic pore pressure (typically greater than 200 feet), a low tip stress (below approximately 50 tons per square feet (tsf)), and a low sleeve friction. The depth to the top surface of this low permeability unit ranges from 115 feet bgs on Base near the source area to 30 feet bgs near the toe of the plume in the City of Roy. A more detailed description of the stratigraphy is provided in the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a).

2.4.2.2. A CPT investigation was completed on the railroad corridor property at 16 locations to define site stratigraphy. Groundwater samples also were collected from 55 discrete intervals to determine the horizontal and vertical extent of the OU 12 TCE plume beneath the site. The stratigraphy and extent of the OU 12 TCE groundwater plume are depicted on Cross Section A-A', which is provided on Figure 2-2. Based on the groundwater sampling, the total vertical extent of TCE contamination is approximately 32 feet below natural ground surface, whereas the total horizontal extent (defined by the 5 μg/l TCE contour) is approximately 660 feet. The depth to the top surface of the low permeability range unit in this area is also at approximately 30 feet bgs across the railroad corridor property.

2.4.2.3. Depth to Groundwater. The depth to groundwater at OU 12 varies from approximately 110 feet bgs on Base to approximately 3 to 5 feet bgs off Base near the railroad corridor property.

2.4.2.4. Piezometric Surface, Groundwater Flow Direction, and Hydraulic Gradients. The groundwater flow direction in OU 12 is predominantly from the east to the west, with local flow directions toward the northwest near the OU 12 source area. The horizontal hydraulic gradient varies across OU 12 ranges from 0.01 to 0.04 feet per foot (ft/ft) with a mean of 0.02 ft/ft. Differences in gradients may be a result of variations in hydraulic conductivity, topography, recharge, and discharge across the area. Vertical hydraulic gradients range from an upward gradient of 0.05 ft/ft to a downward gradient of 0.12 ft/ft across OU 12. However vertical flow is minimal given the low vertical hydraulic conductivities present at the site.

2.4.2.5. Horizontal Hydraulic Conductivity. Estimates of horizontal hydraulic conductivity for OU 12 are based on in-situ permeability tests (i.e., slug tests) completed at 69 wells tested as part of the RI, and from four constant pumping-rate aquifer tests. Based on the in-situ permeability tests, the hydraulic conductivity at OU 12 ranges from 0.06 to 207 ft/day, with a geometric mean of 7.5 ft/day.

2.4.2.6. The locations of the four aquifer tests (constant-rate pumping tests) that have been performed at OU 12 include: 1) extraction well U5-1123, located on Base near the source of the OU 12 plume; 2) extraction well U12-201, located within the Base Boundary Hydraulic Containment System; 3) extraction well U5-1203, located at Municipal Park in Roy; and 4) extraction well U5-1183, located at 2775 West in Roy immediately west of the railroad corridor. Hydraulic conductivities based on aquifer tests had geometric means of 1.9 ft/day for well U5-1123, 12.1 ft/day for well U12-201, 10.0 ft/day for well U5-1203, and 1.0 ft/day for well U5-1183. These values correspond closely with values obtained from slug tests within the OU 12 plume.

2.4.2.7. The aquifer test at U5-1183 is most representative of conditions at the railroad corridor property, because it was located on 2775 West, immediately west of the property. Aquifer testing at U5-1183 revealed that although the average hydraulic conductivity of the screened interval of the well is 1.0 ft/day, two distinct layers with differing hydraulic conductivities exist at this particular location. The upper unit (approximately 4 to 11 ft bgs) exhibited a hydraulic conductivity of approximately 4 ft/day, while the lower unit (approximately 11 to 30 ft bgs) exhibited a much lower hydraulic conductivity of 0.2 ft/day. Although the upper unit at well U5-1183 is estimated to have a hydraulic conductivity of 4 ft/day, the well could not sustain a pumping rate greater than 2 gallons per minute (gpm). The upper unit at well U5-1183 likely is not laterally continuous and boundary conditions may exist at this location. If not, aquifer storage and hydraulic conductivity should have been adequate to sustain pumping rates greater than 2 gpm.

2.4.2.8. Groundwater Velocity. Using the hydraulic conductivity values from the slug tests and horizontal hydraulic gradients calculated for each well, horizontal average linear velocities for groundwater were calculated assuming an effective porosity of 30 percent (average total porosity is 38 percent based on soil samples collected at OU 12). The average linear velocity of groundwater at OU 12 ranges from 0.004 to 8.5 ft/day, with a geometric mean of 0.52 ft/day (190 ft/year). Based on the hydraulic conductivity data from the slug test performed at U5-1128 on 2700 West and the aquifer test performed at U5-1183 on 2775 West, the average linear velocity at the railroad corridor property could range from 0.01 to 0.7 ft/day.

2.4.2.9. Vertical Hydraulic Conductivity. Vertical hydraulic conductivity values in OU 12 range from 1.2 x 10^{-4} ft/day (4.1 x 10^{-8} centimeters per second [cm/s]) to 18 ft/day (6.3 x 10^{-3} cm/s). The geometric mean of all values is 4.5 x 10^{-3} ft/day (1.6 x 10^{-6} cm/s). The ratio of horizontal to vertical hydraulic conductivity for each well that had a reported vertical conductivity had a geometric mean of approximately 1,700. The high level of anisotropy between the horizontal and vertical hydraulic conductivity values is expected given the interbedded nature of the aquifer, such that the horizontal hydraulic conductivity is controlled by sand, sandy silt, and silty sand layers and the vertical hydraulic conductivity is controlled by silt, clayey silt, and clay layers.

2.5 KNOWN AND SUSPECTED SOURCE AREAS

2.5.0.1. Known and suspected sources of contamination have been found at OU 12, but little is known about source mass or timing of releases. Potential historical sources were examined as part of the *Final Operable Unit 5 and 12 Historic Site and Source Area Review* (MWH, 2002b). A former Wastewater Treatment Plant (see Figure 2-1) was initially the suspected source area for the TCE plume. However, field investigations in the potential OU 12 source areas indicate that the primary source of the OU 12 TCE plume is located within the AADA. Investigations in this area have identified buried drums and a tar-like layer approximately 1 to 5 feet bgs, that contains significant amounts of TCE (i.e., up to 112,000 micrograms per kilogram [μg/kg]) in three localized areas within the general source area. Contamination also has been identified in the deeper vadose zone beneath the source zone. The former Wastewater Treatment Plant sludge drying beds and drain field area may be a source of carbon tetrachloride contamination.

2.6 NATURE AND EXTENT OF CONTAMINATION

2.6.0.1. The primary contaminants in groundwater at OU 12 are VOCs and those detected above their respective MCLs include TCE, carbon tetrachloride, and PCE. PCE contamination at OU 12 is not believed to be associated with Hill AFB as detections have been sporadic across the plume area; and PCE has only been detected at a concentration greater than its MCL from a single sampling event at a single monitoring well. The *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a) presents the details of the nature and extent of contamination observed at OU 12. All analytical data are provided in the appendices of the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a).

2.6.0.2. The most widespread contaminant in groundwater at OU 12 is TCE. The TCE plume extends approximately 8,500 feet from the source area on Base to the leading edge, which is located beneath the City of Roy. Based on current data, groundwater with TCE concentrations of 5 μg/l or greater underlies a land surface area of 126 acres. The highest TCE concentration observed in groundwater was 1,500 μg/l in January 2003. The maximum TCE concentration in the railroad corridor property is estimated to be 176 μg/l, based on groundwater samples collected from CPT direct-push sampling location U5-2213 and 180 μg/l from monitoring well U5-1207.

2.6.0.3. Dimethyl phthalate, a semi-volatile organic compound (SVOC), does not have an MCL, but has been detected in a number of wells at OU 12, primarily on Base. Metals at OU 12 have not been detected consistently in groundwater and do not appear to be a result of contamination at Hill AFB. Antimony and arsenic are the only metals that have been detected above their respective MCLs at OU 12.

2.6.0.4. Based on the observed nature and extent of contamination and the site characteristics at OU 12, the factors that primarily influence contaminant migration include site stratigraphy and hydraulic gradients. Chemical and geochemical evidence suggests that biodegradation of TCE is occurring via reductive dehalogenation in limited areas off Base; however, the rate at which it is occurring is very slow, due to the carbon limiting conditions found in the aquifer. Groundwater flow and contamination transport modeling indicates that groundwater contamination with TCE will likely continue to expand westward. Early remedial actions have been undertaken at OU 12 and will impact contaminant fate and transport. These systems are described below.

2.7 SUMMARY OF EARLY ACTIONS

2.7.0.1. Hill AFB has implemented a non-time-critical remedial action at OU 12 as a treatability study in an effort to reduce migration of contaminants in groundwater to off-Base areas. Hill AFB also has implemented several time-critical removal actions to minimize exposure to contaminants in indoor air. Early actions include the OU 12 HCS, installed as a treatability study, and individual indoor air mitigation systems, installed as time-critical removal actions as part of a Base-wide program.

2.7.1 Base Boundary Hydraulic Containment System

2.7.1.1. The OU 12 HCS consists of an array of three extraction wells that was installed along the Base boundary to capture contaminated groundwater (with TCE concentrations greater than 100 μg/l) associated with the OU 12 source area and prevent further migration of contaminants from the on-Base source area to off-Base areas. This system was installed as a treatability study. Containing the TCE-contaminated groundwater will allow for the implementation of additional treatability studies or actions in the upgradient source area while preventing further migration of contaminated groundwater to off-Base areas. Operation of the OU 12 HCS began in April 2003. Effluent is discharged to the sanitary sewer for treatment at the North Davis County Sewer District (NDCSD) Wastewater Treatment Plant. The details of design and technical approach for the system can be found in the *Final Operable Unit 12 Base Boundary Hydraulic Containment System Treatability Study Work Plan* (MWH, 2002c).

2.7.2 Air Mitigation Systems

2.7.2.1. Indoor air sampling at residences overlying the OU 12 groundwater contamination plume revealed that the contaminant concentrations in the indoor air of some residences exceeded Hill AFB Draft Mitigation Action Levels (MALs) as developed in the *Final Basewide Air Sampling and Analysis Plan: Indoor Residential Air Sampling* (MWH, 2004). As a result, indoor air mitigation systems have been installed at nine residences to reduce or eliminate the contamination in indoor air caused by vapor migration from the contaminated shallow groundwater into soil and indoor air.

2.7.2.2. The indoor air mitigation systems consist of a vent pipe that is directly connected to a suction point that is cut through the basement floor slab. An exhaust fan is connected to the vent pipe, which creates a negative pressure below the basement slab, resulting in collection of vapors before they enter the house. Vapors are subsequently vented outside of the house. Due to the low contaminant concentrations produced, no treatment of the vented effluent is necessary. For more details, refer to the *Final Basewide Air Sampling and Analysis Plan: Indoor Residential Air Sampling* (MWH, 2004).

2.7.2.3. All nine of the systems have operated continuously since installation. Performance monitoring of these systems has been conducted which has shown that all systems have succeeded in reducing indoor air VOC concentrations to levels below the Hill AFB Draft MALs.

2.8 STREAMLINED RISK EVALUATION

2.8.0.1. A BRA was prepared to evaluate the risks to human health and the environment in relation to contamination at OU 12. The results of the BRA are presented in detail in the *Internal Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003a). Because the proposed removal action includes installation of a groundwater containment system in the off-Base groundwater plume, this section will summarize the results of the BRA with respect to the off-Base receptors.

2.8.0.2. Off-Base construction workers, off-Base residents, and recreational visitors were considered under current land uses. There were no human health risks that require remediation under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). However, carbon tetrachloride and TCE in indoor air off-Base were estimated to have a combined cancer risk in excess of one in one hundred thousand (1×10^{-5}), which is in a range where there is regulatory discretion regarding whether to remediate (i.e., between 1×10^{-4} to 1×10^{-6}). Hill AFB has chosen to install mitigation systems in homes where TCE concentrations exceeded the Draft MALs.

2.8.0.3. The evaluation of the potable water scenario for off-Base residents concluded that the shallow aquifer is not an acceptable source of potable water, and would pose unacceptable risks if used for this purpose at OU 12. However, there is no known current use of groundwater for this purpose and future use is not expected.

2.8.0.4. The ecological risk assessment considered aquatic and terrestrial habitats within OU 12. It was performed as a screening level assessment. Based on chemical concentrations in a nearby upgradient monitoring well and considering the limited habitat available, there are no significant ecological risks in the off-Base drainage area.

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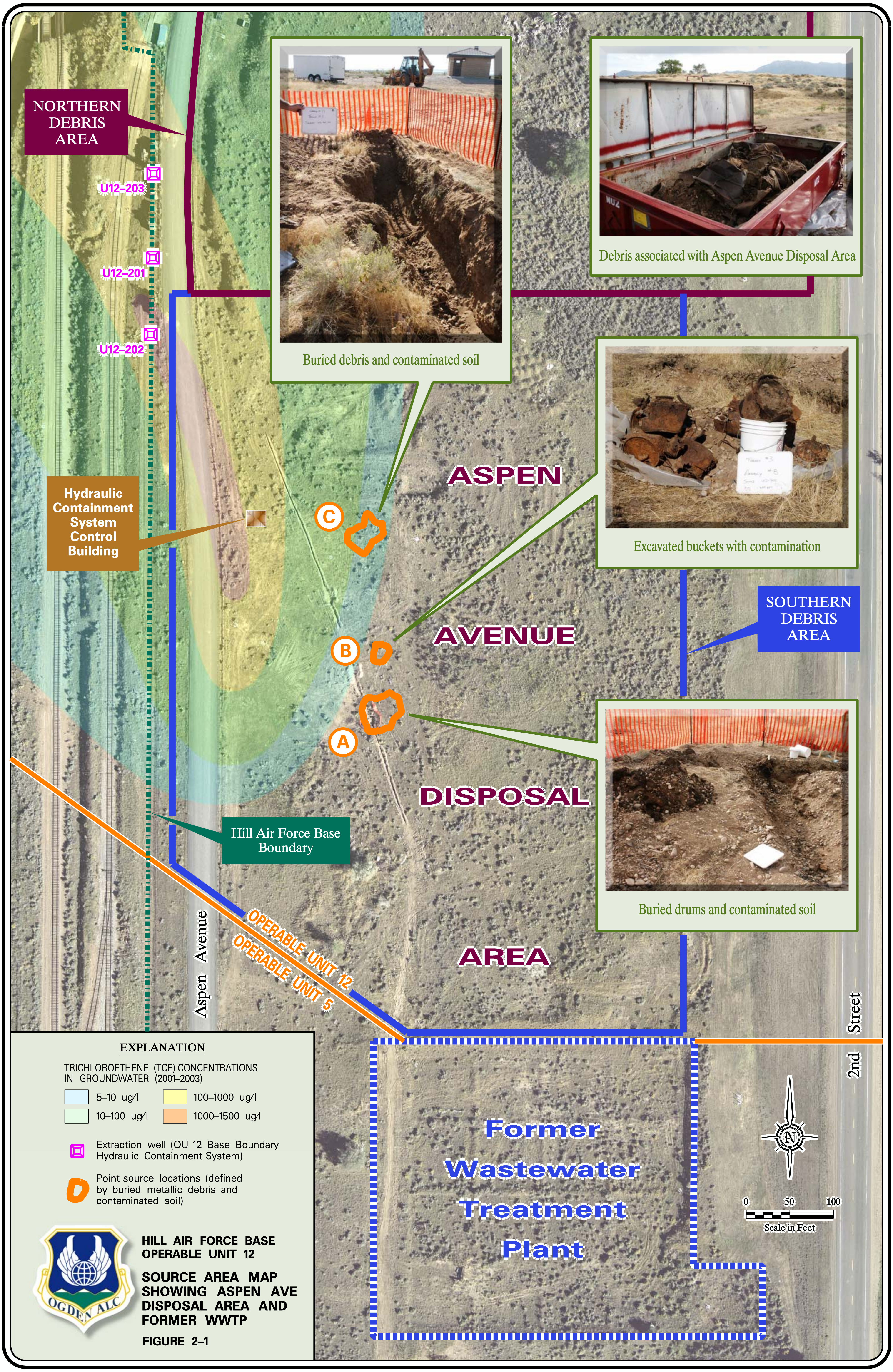
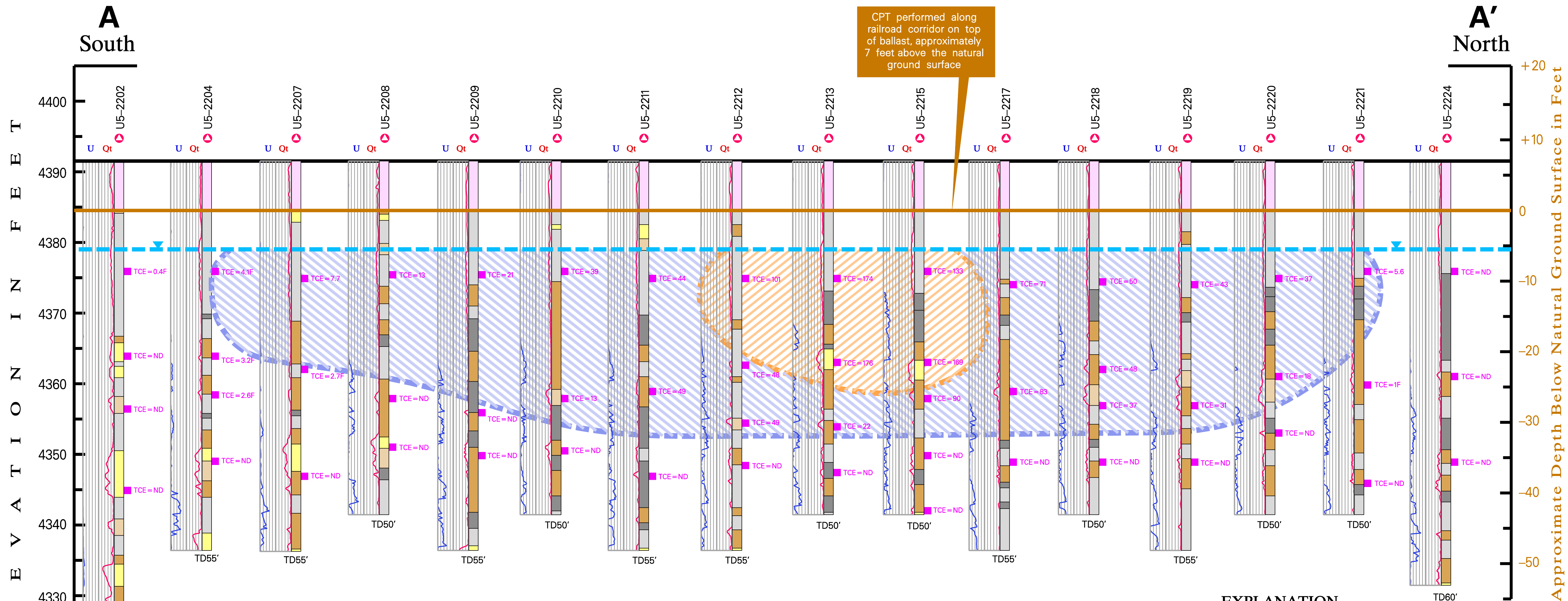
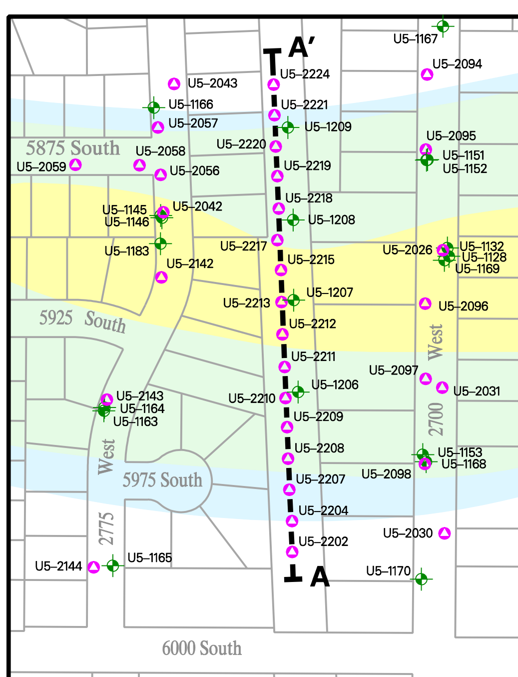
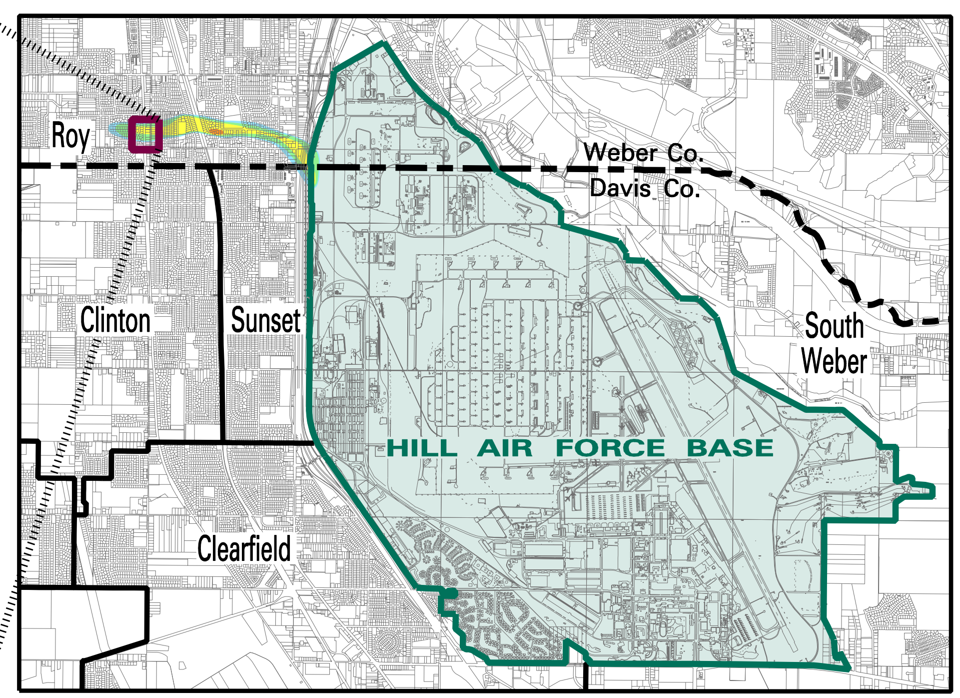




CROSS-SECTION LOCATION MAP



INDEX MAP



EXPLANATION

●	Cone penetration test (CPT)
—	Approximate natural ground surface
▼	Approximate water table position
U	Dynamic pore pressure (0–500 ft)
Qt	Tip stress (0–500 tons per ft^2)
ug/l	Micrograms per liter
■	Direct-push sampling location (TCE concentration in ug/l)
MCL	Maximum contaminant level
TCE	Trichloroethene
ND	TCE not detected
F	Analyte was positively identified but the associated numeric value is below the practical quantitation limit

STRATIGRAPHY
(Stratigraphic sequence interpreted from CPT)

🟪	Fill material
🟨	Sand
🟫	Interbedded sand and silt
🟧	Interbedded silt and sand
⬜	Silt
⬛	Clay

TCE CONCENTRATIONS IN GROUNDWATER (MCL=5 ug/l)

▨	5–100 ug/l
▨	100–200 ug/l

HILL AIR FORCE BASE
OPERABLE UNIT 12

UTA PROPERTY
CROSS SECTION A–A'
(Looking West)

FIGURE 2–2

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3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

3.0.0.1. The NCP establishes the framework for Hill AFB to take appropriate removal actions to contain and mitigate releases that pose a threat to public health and welfare or to the environment (40 CFR Section 300.415 [b][2]). The NCP Section 300.415 (i) requires that removal actions attain or exceed State and Federal ARARs to the maximum extent practicable, considering the constraints of the situation. The site-specific factors that justify a non-time-critical removal at OU 12 include:

1) The OU 12 groundwater plume is not believed to be stable and will continue to migrate downgradient resulting in further groundwater degradation. The contaminated groundwater has the potential to emerge into residential basements due to shallow groundwater conditions that exist in this area.

2) VOCs found in the groundwater plume also have been detected in indoor air at several residences at concentrations exceeding their respective MALs as defined in the *Final Basewide Air Sampling and Analysis Plan Indoor Residential Air Sampling* (MWH, 2004). Indoor air mitigation systems have been installed at these locations to address the contamination in the residence in accordance with the *Final Action Memorandum for Time-Critical Removal Actions for Indoor Air* (MWH, 2003b), but the systems do not address the cause of the problem in groundwater or prevent the groundwater contamination from migrating further downgradient and potentially resulting in further indoor air problems.

3.1 STATUTORY LIMITS OF REMOVAL ACTION

3.1.0.1. Section 104 of CERCLA addresses the response authority for releases or threats of releases at a site. The U.S. EPA, the Utah Department of Environmental Quality (UDEQ), and Hill AFB Federal Facilities Agreement, Section 7.6, recognize that the response authority has been delegated to the United State Air Force. The statutory limits of a 12-month removal action duration and 2-million dollar expenditure for each removal action, are presented in Section 104(e)(i) of the Superfund Amendments and

Reauthorization Act (SARA) of 1986. These limits do not apply to removal actions not financed by Superfund monies, such as the proposed removal action at OU 12.

3.2 REMOVAL ACTION SCOPE, OBJECTIVES, AND GOALS

3.2.0.1. As briefly described in Section 1.0, three removal action alternatives (aeration curtain, slurry wall and extraction trench, and a PRB wall) are being evaluated as part of this EE/CA. The scope of the removal action proposed in this document is intended to provide stabilization of the TCE plume until the final site remedy can be implemented. Removal action objectives (RAOs) are site-specific, qualitative and/or quantitative goals that define the extent of cleanup required for a removal action. To meet the scope, RAOs have been developed and include the following:

1) To reduce the potential for further downgradient degradation of groundwater quality by preventing the uncontrolled movement of the existing plume.

2) To reduce the potential for further degradation of indoor air contamination that can be attributed to the OU 12 groundwater contaminant plume.

3) To minimize impacts to the community during remedy construction and operation.

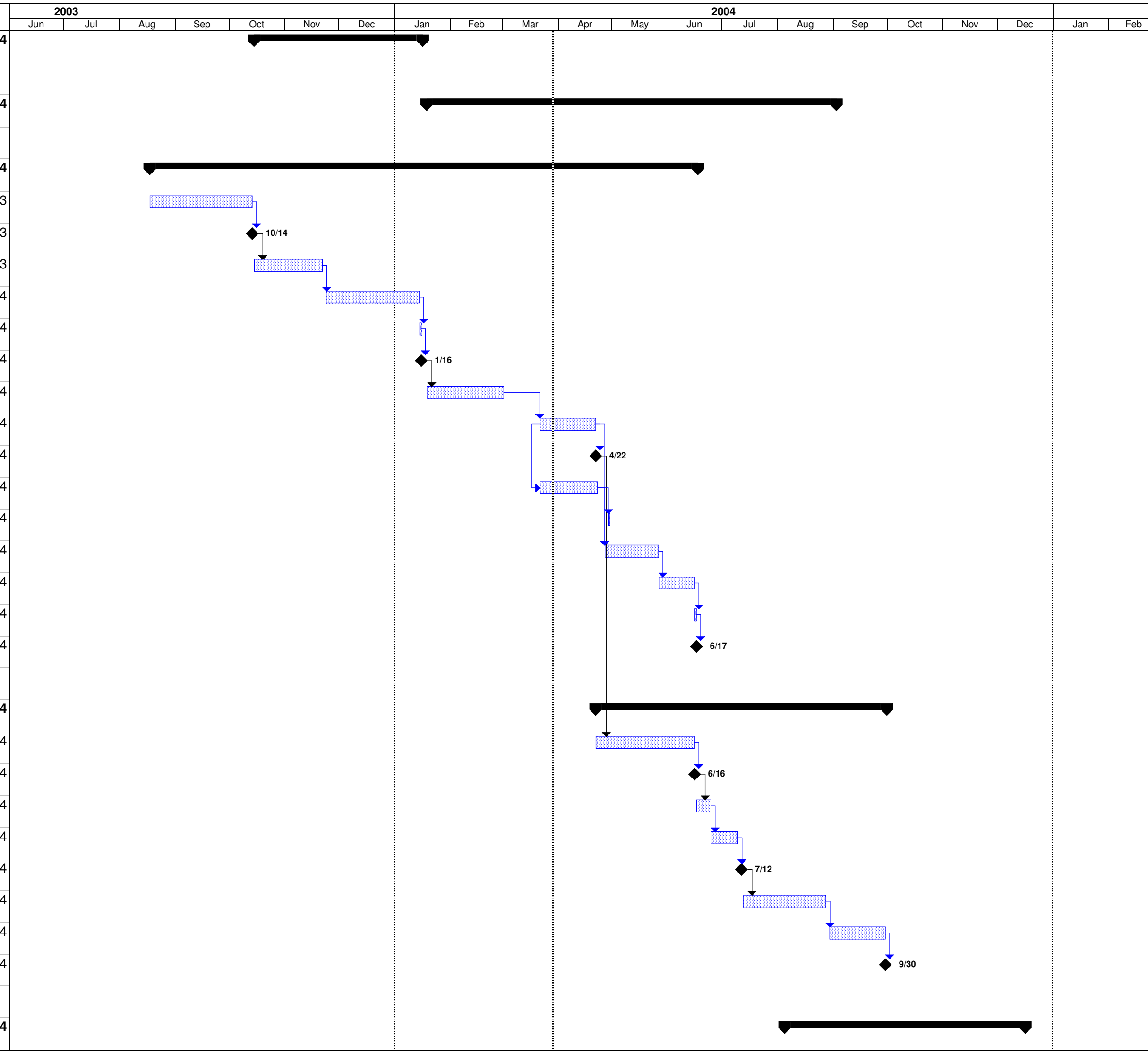
The goals of these RAOs are to: 1) reduce concentrations in groundwater to less than their MCLs at the downgradient performance monitoring points, and 2) be consistent with any existing and future remedial activities.

3.3 REMOVAL ACTION SCHEDULES

3.3.0.1. A summary schedule for the proposed removal action is presented in Figure 3-1. More detailed schedules specific to each removal action alternative are presented in Section 4.

HILL AIR FORCE BASE OPERABLE UNIT 12 - GENERALIZED EE/CA SCHEDULE FOR INSTALLATIOIN OF EARLY REMEDIAL ACTION

ID	Task Name	Start	Finish
1	**Site Investigation**	**Wed 10/15/03**	**Fri 1/16/04**
4			
5	**Baseline Monitoring**	**Mon 1/19/04**	**Thu 9/2/04**
10			
11	**EE/CA Report**	**Mon 8/18/03**	**Thu 6/17/04**
12	MWH Prepares Internal Draft EE/CA	Mon 8/18/03	Mon 10/13/03
13	MWH submits Draft EE/CA to Hill AFB	Tue 10/14/03	Tue 10/14/03
14	Hill AFB Review Internal Draft EE/CA	Wed 10/15/03	Fri 11/21/03
15	MWH RTC and Prepare Draft EE/CA Report	Mon 11/24/03	Wed 1/14/04
16	MWH Submits Draft EE/CA Report to Hill AFB	Thu 1/15/04	Thu 1/15/04
17	Hill AFB Submits Draft EE/CA to Regulators	Fri 1/16/04	Fri 1/16/04
18	Regulatory Review of Draft EE/CA Report	Mon 1/19/04	Mon 3/1/04
19	MWH RTC to Regulatory Comments and Produce Final EE/CA	Mon 3/22/04	Wed 4/21/04
20	MWH Submits Final EE/CA to Hill AFB	Thu 4/22/04	Thu 4/22/04
21	Hill AFB Produce/mail Information Sheet to Residents	Mon 3/22/04	Thu 4/22/04
22	Public Meeting	Thu 4/29/04	Thu 4/29/04
23	30-Day Public Comment Period Begins	Tue 4/27/04	Wed 5/26/04
24	Hill AFB Compile Public Comments - MWH Support	Thu 5/27/04	Tue 6/15/04
25	Final Decision Meeting with Regulators	Wed 6/16/04	Wed 6/16/04
26	Hill AFB Notify Public of EE/CA Signing	Thu 6/17/04	Thu 6/17/04
27			
28	**Action Memorandum**	**Thu 4/22/04**	**Thu 9/30/04**
29	MWH Prepares Internal Draft Action Memo	Thu 4/22/04	Tue 6/15/04
30	MWH Submit Internal Draft Action Memo to Hill AFB	Wed 6/16/04	Wed 6/16/04
31	Hill AFB Review Internal Draft Action Memo	Thu 6/17/04	Thu 6/24/04
32	MWH Response to Comment and Prepare Draft Action Memo	Fri 6/25/04	Fri 7/9/04
33	MWH Submit Draft Action Memo to Hill AFB and Regulators	Mon 7/12/04	Mon 7/12/04
34	Regulator Review	Tue 7/13/04	Fri 8/27/04
35	MWH Response to Comments and Prepare Final Action Memo	Mon 8/30/04	Wed 9/29/04
36	Hill AFB Submit Final Action Memo To Regulators	Thu 9/30/04	Thu 9/30/04
37			
38	**Early Action Installation**	**Thu 8/5/04**	**Thu 12/16/04**



Project: FIGURE3-1Generalschedule.MPP
Date: Mon 3/29/04

Task	Progress	Milestone	Summary
Rolled Up Task	Rolled Up Milestone	Rolled Up Progress	

FIGURE 3-1 PROPOSED EE/CA SCHEDULE

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

4.0.0.1. The proposed early action includes a groundwater plume containment system to be located in the OU 12 off-Base area at the railroad corridor property between 2700 West and 2775 West in the City of Roy (see Figure 1-1) to achieve RAOs. As described in Section 1.0, construction of a removal action on the railroad property achieves the remedial action objective of minimizing impacts to the community in terms of residents affected, constructability, and cost. This achieves compliance with RAO #3 presented in Section 3.0. Other sites considered for the removal action included the street at 2700 West, the backyards of properties on the west side of 2700 West, and the street at 2775 West. These sites were eliminated from further consideration due to increased impacts to the community, constructability and site access issues, and cost.

4.0.0.2. This section describes three alternatives considered for the plume containment system and analyzes each of the alternatives for EE/CA criteria such as effectiveness, implementability, and cost. Each of the systems would be designed to contain the entire width of the OU 12 TCE plume as defined by the MCL (5 μg/l) at the railroad corridor (approximately 660 ft). The three alternatives considered for the proposed early removal action are therefore:

Alternative 1 - Aeration Curtain

Alternative 2 - Slurry Wall and Extraction Trench

Alternative 3 - PRB Wall.

4.1 REMOVAL ACTION ALTERNATIVES

4.1.1 Alternative 1 - Aeration Curtain

4.1.1.1. The aeration curtain employs the principles of air sparging (AS) and soil vapor extraction (SVE) technologies to provide groundwater treatment of VOCs. A series of pipes installed inside a subsurface trench blow air through contaminated groundwater, creating a curtain of bubbles that volatilize the VOCs from groundwater into the vadose zone. A vapor extraction system located in the vadose zone then captures the contaminant vapors for further treatment and disposal.

4.1.1.2. Removal of the VOCs from groundwater prevents the contaminant plume from migrating further, achieving compliance with RAO #1, and by reducing the concentration of VOCs in groundwater, complies with RAO #2 (see Section 3.2).

4.1.1.3. At the railroad corridor site, the aeration curtain would be approximately 660 feet long, 3 feet wide and 30 feet deep and approximately perpendicular to groundwater flow (see Figure 4-1). The trench would be backfilled with a graded gravel pack to reduce siltation. The air sparge system would consist of 22 sections of 4-inch diameter high-density polyethylene (HDPE) pipe in 30-foot horizontal slotted sections with 30-foot risers. The slot size and frequency in the sparge pipes would gradually increase from the inlet end of the section to the far end of the pipe to allow for an even distribution of air flow along the length of the sparge pipe. Based on preliminary estimates, blowers rated at 18 to 20 psi would be used for sparging. The sparge pipe sections would be located at approximately 29 feet bgs in the trench. The sparge header pipes would run parallel to the entire length of the aeration curtain in 30-foot increments with lengths ranging from 630 feet to 20 feet long at the south end of the trench. The header lines would extend an additional 200 to 300 feet from the south end of the trench to a treatment building (20 ft x 16 ft) which would house the blowers and all other equipment and instrumentation. The treatment building would be constructed at a City-owned vacant lot located at the intersection of 2775 West and 6000 South. The header lines would be manifolded in the treatment building and fitted with flow control valves to control air flow from the headers to the sparge pipes. An air-cooled heat exchanger would be installed to cool the pressurized air generated at the air sparge blowers to near ambient temperatures.

4.1.1.4. The SVE system would consist of 4-inch diameter poly-vinyl chloride (PVC) pipes installed in 60-foot-long sections. Due to the shallow depth of groundwater, the SVE piping will be installed at approximately one foot bgs in the trench to provide for extraction of vapors generated from air sparging. Based on preliminary estimates, blowers rated at five inches of mercury vacuum would be used for extraction of TCE vapors. Based on site-specific estimates of effluent concentrations, treatment of the off-gases generated from this system would not be necessary as they would be below State treatment levels. An impermeable membrane would be installed above the vapor extraction pipes to reduce loss of vapors through short-circuiting to the ground surface. The trench would be backfilled over the liner to the ground surface with topsoil. Dewatering of groundwater may or may not be necessary during trench excavation depending on the excavation method selected.

4.1.1.5. The construction techniques considered included using sheet piles, biopolymer slurry, and single-pass mechanical trenching. Driving sheet piles to support trench excavation is a laborious and lengthy process and would also generate considerable noise pollution. Given the location of the project in the midst of residential neighborhoods, special measures of reducing the noise levels may be required during construction activities. Guar gum based biopolymer slurries have been increasingly used in the recent decade for excavation support. This method of excavation is less time consuming and less expensive than those using sheet piles. However, this method of supported excavation may require additional berming of the trench due to the shallow water table. The mechanical trencher technology has become prevalent in recent years for trenching with simultaneous backfill that eliminates the need for supporting the excavation walls. However, this method of construction was eliminated for the aeration curtain due to the limited accuracy of being able to install the slotted sparge sections horizontally at the bottom of the trench. Hence, the aeration trench excavation will be supported using the biopolymer slurry method.

4.1.1.6. The contaminated soil excavated from the trench would be either disposed of as non-hazardous waste at the Hill AFB landfill facility, or more likely remain on site if testing demonstrates compliance with EPA Region III April 2003 Risk Based Criteria for soils, residential exposure level (1.6 milligrams per kilogram [mg/kg] for TCE). Approximately two to three feet of on-site topsoil would be stored on site and later used to backfill over the trench. A set of 15 monitoring wells strategically located around the aeration curtain would be used for evaluating the performance of this system. Figure 4-2 presents a proposed schedule for this alternative and includes time for completion of the EE/CA documents, public comment, completion of an Action Memorandum, Hill AFB procurement of a subcontractor, design of the selected removal action, construction, and final public notification of project completion.

4.1.2 Alternative 2 - Slurry Wall and Extraction Trench

4.1.2.1. The combination of a slurry wall and an extraction trench is designed to capture and extract shallow contaminated groundwater while reducing water table drawdown to minimize settlement-induced stresses on the nearby structures. A gravel-filled groundwater extraction trench would be installed for hydraulic gradient control and collection of contaminated groundwater, which would be discharged to the local publicly operated treatment works (POTW) for treatment and final disposal. A slurry wall of equal length would be installed parallel to and downgradient of the extraction trench to provide for containment of the contaminant plume and reduce the drawdown required to achieve capture.

4.1.2.2. Removal of the groundwater contaminated with VOCs prevents the contaminant plume from migrating further, achieving compliance with RAO #1, and by reducing the concentration of VOCs in groundwater, complies with RAO #2 (see Section 3.2).

4.1.2.3. At the railroad corridor site, the extraction trench and slurry wall would be of equal length at 660 feet and both would be constructed to a depth of approximately 30 feet bgs (see Figure 4-3). The gravel-filled extraction trench would be 18 inches wide. A 4-inch diameter HDPE slotted screen would be installed approximately one foot above the bottom of the trench to collect contaminated groundwater. A 4-foot diameter concrete manhole sump would be installed from the ground surface to 35 feet bgs at the south end of the trench to facilitate collection and discharge of groundwater. One end of the 4-inch diameter HDPE screen would connect to the concrete sump. The other end of the HDPE screen would be brought to the surface at the north end of the trench opposite the vertical sump to act as a clean-out. Two submersible pumps would be installed in the 4-foot diameter concrete sump to pump the collected groundwater up to a equalization tank within a control building (20 ft x 16 ft) which would be located in the City-owned vacant lot located at the intersection of 6000 South and 2775 West. The control building would also house the instrumentation and discharge pumps required to pump the groundwater to the closest sewer manhole located on 6000 South.

4.1.2.4. The slurry wall would be installed parallel to and downgradient of the extraction trench. The slurry wall would be constructed from a mixture of native soils with bentonite slurry and would be a nominal 29 inches wide and have a hydraulic conductivity of approximately $1x10^{-7}$ cm/sec or less. Predesign mixing tests would be performed by the trench installer using native soil, bentonite and water to determine the amount of bentonite required to achieve the design specifications. The separation between the extraction trench and the slurry wall would be 15 to 20 feet. Approximately 10 monitoring wells and 16 piezometers strategically located around the extraction trench and the slurry wall would be used for evaluating the performance of this system over the years of operation.

4.1.2.5. Although other construction methods were considered, a single pass mechanical trencher would be employed to construct both the extraction trench and slurry wall due to the speed of installation and lower construction costs. A laser guided system controls the depth of the cutting boom during installation to ensure that the trench would be installed to the grades specified, plus or minus 0.1 feet. The contaminated soil extracted from the trench would be either disposed of as a non-hazardous waste at the Hill AFB landfill facility, or more likely remain on site if testing demonstrates compliance with EPA Region III April 2003 Risk Based Criteria for soils, residential exposure level (1.6 mg/kg for TCE).

4.1.2.6. A wastewater discharge permit would be required from the North Davis County Sewer District to discharge the extracted groundwater for treatment and final disposal. Based on the expected VOC concentrations in the extracted groundwater, it is estimated that no pre-treatment would be necessary prior to discharge to the sanitary sewer. Quarterly sampling of the discharge may be required to monitor for VOCs, metals and other water quality parameters. Figure 4-4 presents a proposed schedule for this alternative and includes time for completion of the EE/CA documents, public comment, completion of an Action Memorandum, Hill AFB procurement of a subcontractor, design of the selected removal action, construction, and final public notification of project completion.

4.1.3 Alternative 3 – Permeable Reactive Barrier (PRB) Wall

4.1.3.1. The PRB wall constructed of a granular zero valent iron (ZVI) and sand mixture, allows contaminated groundwater to pass through the reactive zone of the barrier whereby the contaminants are chemically transformed to a less toxic state.

4.1.3.2. Destruction of VOCs in groundwater prevents the contaminant plume from migrating further, achieving compliance with RAO #1, and by reducing the concentration of VOCs in groundwater, complies with RAO #2 (see Section 3.2).

4.1.3.3. At the railroad corridor, the PRB wall would be approximately 660 feet long and approximately perpendicular to groundwater flow (see Figure 4-5). The depth of the PRB wall would be approximately 30 feet bgs. As this is a passive groundwater treatment system, it does not involve any discharge from the system. Therefore, ancillary equipment and structures are not required. However, a set of 16 monitoring wells strategically located around the PRB wall would be used for evaluating the performance of this system.

4.1.3.4. Although other construction methods were considered, a single pass mechanical trencher would be employed to install the system with simultaneous backfill of the sand and iron mixture. The contaminated soil extracted from the trench would be either disposed of as a non-hazardous waste at the Hill AFB landfill facility, or more likely remain on site if testing demonstrates compliance with EPA Region III April 2003 Risk Based Criteria for soils, residential exposure level (1.6 mg/kg for TCE). Figure 4-6 presents a proposed schedule for this alternative and includes time for completion of the EE/CA documents, public comment, completion of an Action Memorandum, Hill AFB procurement of a subcontractor, design of the selected removal action, construction, and final public notification of project completion.

4.2 ANALYSIS OF REMOVAL ACTION ALTERNATIVES

4.2.0.1. This section presents the analysis of the removal action alternatives with respect to the short-term and long-term aspects of the following criteria:

- **Effectiveness:** The effectiveness of an alternative refers to its ability to meet the objective within the scope of the removal action while achieving overall protection of public health and the environment.

- **Implementability:** The implementability criterion addresses the technical and administrative feasibility of various services and materials required during implementation of an alternative.

- **Cost:** Each removal action alternative is evaluated to determine its projected costs that include the capital and Post-Removal Site Control (PRSC) costs. The PRSC costs include annual operation & maintenance (O&M) costs, institutional control costs, 5-year status report writing costs, etc. Since all three alternatives would last longer than one year, total present worth costs are also estimated.

4.2.0.2. Table 4-1 presents the detailed analysis of the three alternatives with respect to the above criteria.

TABLE 4-1

DETAILED ANALYSIS OF NON-TIME-CRITICAL REMOVAL ACTIONS
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

Criteria	Alternative 1 Aeration Curtain	Alternative 2 Slurry Wall and Extraction Trench	Alternative 3 Permeable Reactive Barrier Wall
OU 12 Contaminants	Contaminants in OU 12 groundwater are mainly VOCs, with TCE being the primary contaminant.		
EARLY REMOVAL ACTION OBJECTIVES (RAOs) AND GOALS	This proposed removal action involves the design and construction of a containment system in the off-Base TCE groundwater plume at the railroad corridor site, which is located between 2700 West and 2775 West in the City of Roy. The primary objective for this removal action is to reduce the potential for further downgradient degradation of groundwater quality while minimizing impacts to the community. The primary goal for this early removal action is to reduce TCE concentrations in groundwater to the MCL (5 µg/l) or lower at the downgradient performance monitoring points of the proposed groundwater containment system.		
ALTERNATIVE DESCRIPTION	A series of pipes installed in a gravel-filled trench blow air through contaminated groundwater, creating a curtain of bubbles that volatilize the contaminants from groundwater (air sparging). A vapor extraction system then captures the vapors from the soil for further treatment and disposal. The 660-foot long and approximately 30-foot deep aeration curtain would be located approximately perpendicular to groundwater flow to intersect the currently-defined 5 mg/l TCE isoconcentration contour at the railroad corridor site located between 2700 West and 2775 West in the City of Roy. See Figure 4-1.	Contaminated groundwater would collect in a gravel-filled extraction trench and be pumped to the POTW for treatment and disposal. A slurry wall of equal length will be located parallel to and downgradient from the extraction trench to provide containment of the contaminant plume and reduce the drawdown required to achieve capture. Both the slurry wall and extraction trench, each 660 feet in length, would be located approximately perpendicular to groundwater flow (to intersect the 5 mg/L TCE isoconcentration contour) and will have a depth of approximately 30 feet. The system will be located at the railroad corridor located between 2700 West and 2775 West in the City of Roy. See Figure 4-2.	A permeable reactive barrier wall of granular iron and sand would be constructed in the subsurface to allow contaminated water to pass through the reactive zone whereby the contaminants are chemically transformed to a less toxic state. The 660-foot long PRB Wall would be located approximately perpendicular to groundwater flow and will have a total depth of approximately 30 feet. The system will be located at the railroad corridor site located between 2700 West and 2775 West in the City of Roy. See Figure 4-3.
Overall Protection of Human Health and the Environment			
How protective is the alternative to human health and the environment?	Provides protection of human health and environment. Contaminants are removed from groundwater through volatilization. Institutional controls will prevent incidental exposure to groundwater contaminants.	Provides protection of human health and environment. Contaminated groundwater is pumped out of the aquifer and treated at the POTW. Institutional controls will prevent incidental exposure to groundwater contaminants.	Provides protection of human health and environment. TCE is destroyed by the reductive dechlorination process promoted by the zero valent iron present in the PRB Wall. Institutional controls will prevent incidental exposure to groundwater contaminants.
Compliance with ARARs			
Chemical Specific:	Will achieve MCLs at the downgradient performance monitoring points. Will eventually comply with the non-degradation rules of R315-101-3 and R311-211 with respect to plume migration. (see Appendix B for more details on ARARs)	Will achieve MCLs at the downgradient performance monitoring points. Will eventually comply with the non-degradation rules of R315-101-3 and R311-211 with respect to plume migration. (see Appendix B for more details on ARARs)	Will achieve MCLs at the downgradient performance monitoring points. Will eventually comply with the non-degradation rules of R315-101-3 and R311-211 with respect to plume migration. (see Appendix B for more details on ARARs)
Location Specific:	There are no location-specific ARARs.	There are no location-specific ARARs.	There are no location-specific ARARs.
Action Specific:	Compliance with ARARs concerning implementation of institutional controls, groundwater monitoring, and air emissions is expected.	Compliance with ARARs concerning implementation of institutional controls, groundwater monitoring, discharge to POTW, and air emissions is expected.	Compliance with ARARs concerning implementation of institutional controls, groundwater monitoring, and air emissions is expected.
Other criteria, advisories, and guidance:	Compliance with "to be considered" (TBCs) concerning well construction restrictions and remediation derived waste (RDW) is expected.	Compliance with TBCs concerning well construction restrictions and RDW is expected.	Compliance with TBCs concerning well construction restrictions and RDW is expected.

TABLE 4-1

DETAILED ANALYSIS OF NON-TIME-CRITICAL REMOVAL ACTIONS
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

Criteria	Alternative 1 Aeration Curtain	Alternative 2 Slurry Wall and Extraction Trench	Alternative 3 Permeable Reactive Barrier Wall
Long-term Effectiveness and Permanance			
Is the alternative a permanent remedy?	Yes. Contaminants in the groundwater are volatilized and treated.	Yes. Contaminated groundwater is removed from the aquifer and treated.	Yes. Contaminants in groundwater are destroyed in-situ through reductive dechlorination.
How does the treatment employed address principal threats?	Contaminants are removed from the groundwater preventing further migration to downgradient locations. Off-gases from the SVE system will be treated as necessary to meet State Air Discharge requirements.	Contaminated groundwater is extracted and discharged to POTW for treatment and final disposal. The combination of extraction trench and slurry wall enforce containment and prevent further migration of contaminants to downgradient locations.	Contaminants in groundwater are destroyed in-situ with the zero valent iron to MCLs preventing further migration to downgradient locations.
What is the magnitude of the health and ecological risks associated with residuals that may remain?	The aeration curtain is designed to provide treatment of VOCs in the groundwater flowing through the system to below ARARs. However, low concentrations of VOCs remaining in the groundwater downgradient portion of the plume not addressed by the remedy would not pose significant health or ecological risks.	The extraction trench will provide treatment of VOCs in the groundwater extracted by the system to below ARARs. However, low concentrations of VOCs remaining in the groundwater in the downgradient part of the plume not addressed by the remedy would not pose significant health or ecological risks.	The PRB will provide treatment of VOCs in the groundwater passing through it to below MCLs. However, low concentrations of VOCs remaining in the groundwater in the downgradient part of the plume not addressed by the remedy would not pose significant health or ecological risks.
How adequate and reliable are controls for management of treatment residuals and untreated wastes?	Adequate and reliable. The aeration curtain coupled with the vapor extraction system prevents contaminants from migrating downgradient being transferred from one media to another (water to vapor); off-gas treatment of captured contaminants is provided, if necessary.	Adequate and reliable. The extraction trench provides hydraulic control to prevent contaminants from migrating downgradient; contaminated groundwater is pumped to POTW for treatment and final disposal.	Adequate and reliable. The PRB treats the groundwater contaminants in-situ preventing contaminant migration downgradient.

TABLE 4-1

DETAILED ANALYSIS OF NON-TIME-CRITICAL REMOVAL ACTIONS
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

Criteria	**Alternative 1** **Aeration Curtain**	**Alternative 2** **Slurry Wall and Extraction Trench**	**Alternative 3** **Permeable Reactive Barrier Wall**
Reduction of Toxicity, Mobility, or Volume Through Treatment			
To what extent is the total toxicity, mobility or volume of contaminants reduced?	Contaminants are contained from further downgradient migration and removed from groundwater to the vadose zone by air sparging.	Contaminants are contained from further downgradient migration and removed by groundwater pumping. Contaminants in the pumped groundwater are reduced in volume and toxicity through treatment at the POTW.	Contaminant volume and toxicity are reduced by in-situ degradation at the PRB.
What residuals remain and to what degree?	Low concentrations of VOCs below MCLs may remain in the shallow groundwater after air sparging. However, this remedy does not address treatment of groundwater contamination present downgradient of the installation site.	Low concentrations of VOCs below MCLs may remain in the shallow groundwater after extraction. However, this remedy does not address treatment of groundwater contamination present downgradient of the installation site.	Low concentrations of VOCs below MCLs may remain in the shallow groundwater after the in-situ treatment. However, this remedy does not address treatment of groundwater contamination present downgradient of the installation site.
What are the uncertainties associated w/land disposal of residuals/untreated wastes?	RDW from the construction activities will be disposed at the appropriate landfills accessible by Hill AFB or kept on site. Groundwater contaminants are stripped by air sparging.	RDW from the construction activities will be disposed at the appropriate landfills accessible by Hill AFB or kept on site. During operation of the system, contaminated groundwater is extracted and discharged to the POTW for treatment.	RDW from the construction activities will be disposed at the appropriate landfills accessible by Hill AFB or kept on site. During operation of the system, groundwater contaminants are destroyed in-situ.
To what extent are the effects of treatment irreversible?	Irreversible treatment. Contaminants are stripped from groundwater and mobilized to the vadose zone and discharged directly to the atmosphere.	Irreversible treatment. Contaminants are removed from the aquifer and discharged to the POTW; extracted groundwater will not be reintroduced to the aquifer.	Irreversible treatment. Contaminants are destroyed in-situ.

TABLE 4-1

DETAILED ANALYSIS OF NON-TIME-CRITICAL REMOVAL ACTIONS
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

Criteria	Alternative 1 Aeration Curtain	Alternative 2 Slurry Wall and Extraction Trench	Alternative 3 Permeable Reactive Barrier Wall
Short-term Effectiveness			
Are there risks to the community during removal actions?	Minimal risks to community. Air sparging/soil venting emit VOCs into the atmosphere, however the volume of VOCs emitted by the system are expected to meet the allowable volume according to State and Federal Rules. If they exceed the deMinimus quantities, the off-gases will be treated to meet the limits. Short-term construction risks such as traffic accidents would be mitigated through standard operating procedures combined with traffic plans and health and safety protocols.	No risks to community as long as containment of contaminants above MCLs is maintained. Short-term construction risks such as traffic accidents would be mitigated through standard operating procedures combined with traffic plans and health and safety protocols.	No risks to community as the contaminants are destroyed in-situ. Institutional Controls and/or indoor air mitigation systems will prevent exposure if vinyl chloride, a toxic daughter product of TCE (typically less than 4% of TCE may convert to vinyl chloride), is generated immediately downgradient of the PRB. Short-term construction risks such as traffic accidents would be mitigated through standard operating procedures combined with traffic plans and health and safety protocols.
Are there risks to workers during removal actions?	Construction risk associated with trench installation mitigated through standard operating procedures combined with health and safety protocols. Minimal exposure risk associated with sparge/vent installation and monitoring. Minimal risk associated with sampling activities.	Construction risk associated with trench installation mitigated through standard operating procedures combined with health and safety protocols. Minimal risk associated with sampling activities.	Construction risk associated with trench installation mitigated through standard operating procedures combined with health and safety protocols. Minimal risk associated with sampling activities.
Are there risks to the environment with implementation of alternative?	No.	No.	No.
What is the time required to reach removal action objectives?	RAOs will be achieved within months of starting operation of the aeration curtain. However, the RAOs do require that the treatment system remain in continuous operation to be in compliance with them. See results of modeling (Appendix A).	RAOs will be achieved within months of starting operation of the extraction trench and slurry wall. However, the RAOs do require that the treatment system remain in continuous operation to be in compliance with them. See results of modeling (Appendix A).	RAOs will be achieved within months of installing the PRB. However, the RAOs do require that the treatment system remain in continuous operation to be in compliance with them. See results of modeling (Appendix A).

TABLE 4-1

DETAILED ANALYSIS OF NON-TIME-CRITICAL REMOVAL ACTIONS
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

Criteria	Alternative 1 Aeration Curtain	Alternative 2 Slurry Wall and Extraction Trench	Alternative 3 Permeable Reactive Barrier Wall
Implementability			
What difficulties are expected during construction and operation?	The shallow depth of groundwater complicates trench construction using the biopolymer slurry and requires additional earthen berm support. Iron/bacteria fouling of sparging system is possible and is a long term O&M concern. Sand plugging of the sparge points. Labor intensive to frequently monitor (e.g., weekly) the sparge pumps and balance the sparge system pressures. Maintenance intensive in replacement parts. Noise pollution is significant; may require significant expenditure for sound-proofing air sparging equipment. Based on Hill AFB experience with a similar system installed in similar hydrogeological conditions (OU 5), semi-annual cleanout of sparge pipes may be required. A treatment building required for housing equipment and instrumentation will have to be located off site due to space limitations and feasibility with site-use issues.	Construction of the extraction trench and slurry wall to proceed in a sequence using a single-pass mechanical trencher. No substantial difficulties foreseen in construction of the overall system. Additional site preparation is required for installing the slurry wall and extraction trench. The slurry wall and extraction trench design with a maximum separation of 20 feet presents a concern for the present and the future due to the presence of the railroad track. A treatment building required for housing equipment and instrumentation will have to be located off site due to space limitations and feasibility with site-use issues.	No substantial difficulties foreseen in construction of the PRB using a single-pass mechanical trencher. No substantial difficulties foreseen during the operation of system.
What is the likelihood the alternative will meet the required removal action objectives?	Will meet the RAOs.	Will meet the RAOs.	Will meet the RAOs.
Is there flexibility to undertake additional remedial actions, if necessary?	Yes.	Yes.	Yes.
How well can the alternative be monitored?	Easily monitored. Groundwater sampling will monitor conditions of the aquifer. Off-gas monitoring will evaluate removal effectiveness of the aeration curtain.	Monitoring of containment or effectiveness of plume capture may prove difficult with seasonal water level fluctuations. Sampling will monitor conditions of the aquifer and sanitary sewer discharge; flow rates monitored to evaluate containment effectiveness.	Easily monitored. Groundwater sampling will monitor the effectiveness of the PRB wall for in-situ remediation of VOCs.
What difficulties are expected in obtaining approvals from other agencies?	Construction and operation permits require approvals from UDEQ and EPA. Requires compliance with the State deMinimus regulations for off-gas discharge.	Construction and operation permits require approvals from UDEQ and EPA. Requires compliance with POTW discharge permit for disposal of contaminated groundwater to the POTW.	Construction and operation permits require approvals from UDEQ and EPA.
What other coordination tasks are required of other agencies?	Coordination with other agencies not necessary.	Coordination with POTW is required.	Coordination with other agencies not necessary.

TABLE 4-1

DETAILED ANALYSIS OF NON-TIME-CRITICAL REMOVAL ACTIONS
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

Criteria	Alternative 1 Aeration Curtain	Alternative 2 Slurry Wall and Extraction Trench	Alternative 3 Permeable Reactive Barrier Wall
What is the availability and capacity of off-site treatment, storage and disposal services?	Not applicable. Groundwater will not be discharged off site. Off-gases from the SVE system will be directly discharged to the atmosphere without pretreatment.	POTW will be petitioned for a discharge permit. No foreseen difficulties with POTW capacity in obtaining the discharge permit.	Not applicable. Groundwater will not be discharged off site.
What type/degree of long-term management is required?	Long-term groundwater monitoring would be required. Long-term management of the aeration curtain would be required. It is estimated to be intensive in labor and part replacement costs.	Long-term groundwater monitoring would be required. Long-term operation and maintenance of the extraction and discharge system would be required.	Long-term groundwater monitoring would be required. Minimal long-term management required for the operation of the PRB.
Are services and materials available?	Yes.	Yes.	Yes.
Is the technology generally available and sufficiently demonstrated?	Yes. Air sparging has been demonstrated for extracting VOCs from groundwater.	Yes. Slurry wall and groundwater extraction is a proven technology for containing groundwater. Discharge to POTW is commonly used for groundwater with low concentrations of VOCs.	Yes. PRBs have been proven for in-situ treatment of TCE and other chlorinated solvent compounds.
Cost	(see Appendix C for more details on costs)	(see Appendix C for more details on costs)	(see Appendix C for more details on costs)
30 Year Present Worth (PW) Costs:	**$6,271,000**	**$4,070,000**	**$2,356,000**
-30% to +50% Range	**$4,389,700 to $9,406,500**	**$2,849,000 to $6,105,000**	**$1,649,200 to $3,534,000**
Community Acceptance	To be evaluated during the public comment period after issuance of the Action Memorandum.	To be evaluated during the public comment period after issuance of the Action Memorandum.	To be evaluated during the public comment period after issuance of the Action Memorandum.
State Acceptance	To be evaluated after issuance of the Action Memorandum.	To be evaluated after issuance of the Action Memorandum.	To be evaluated after issuance of the Action Memorandum.

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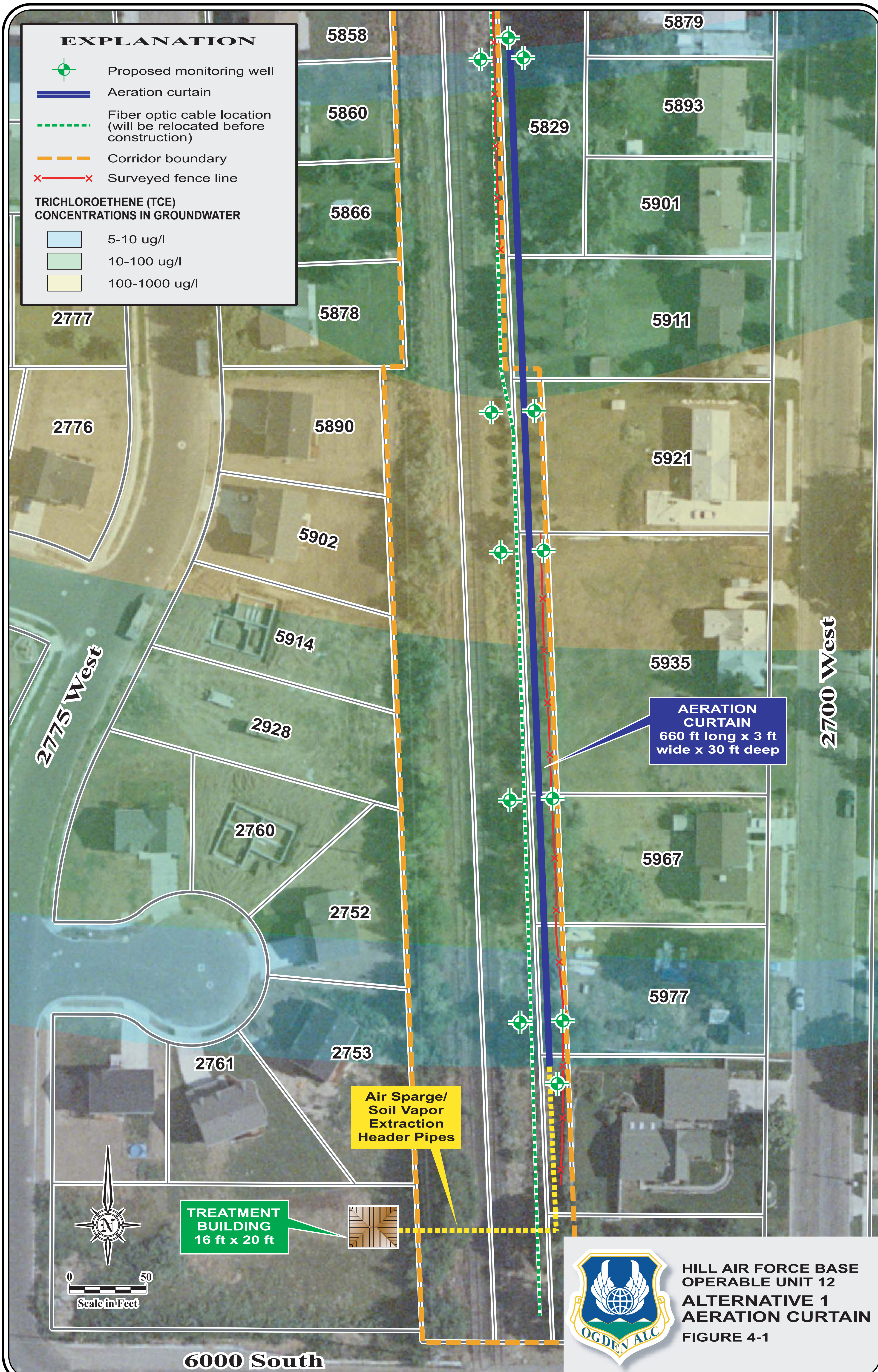
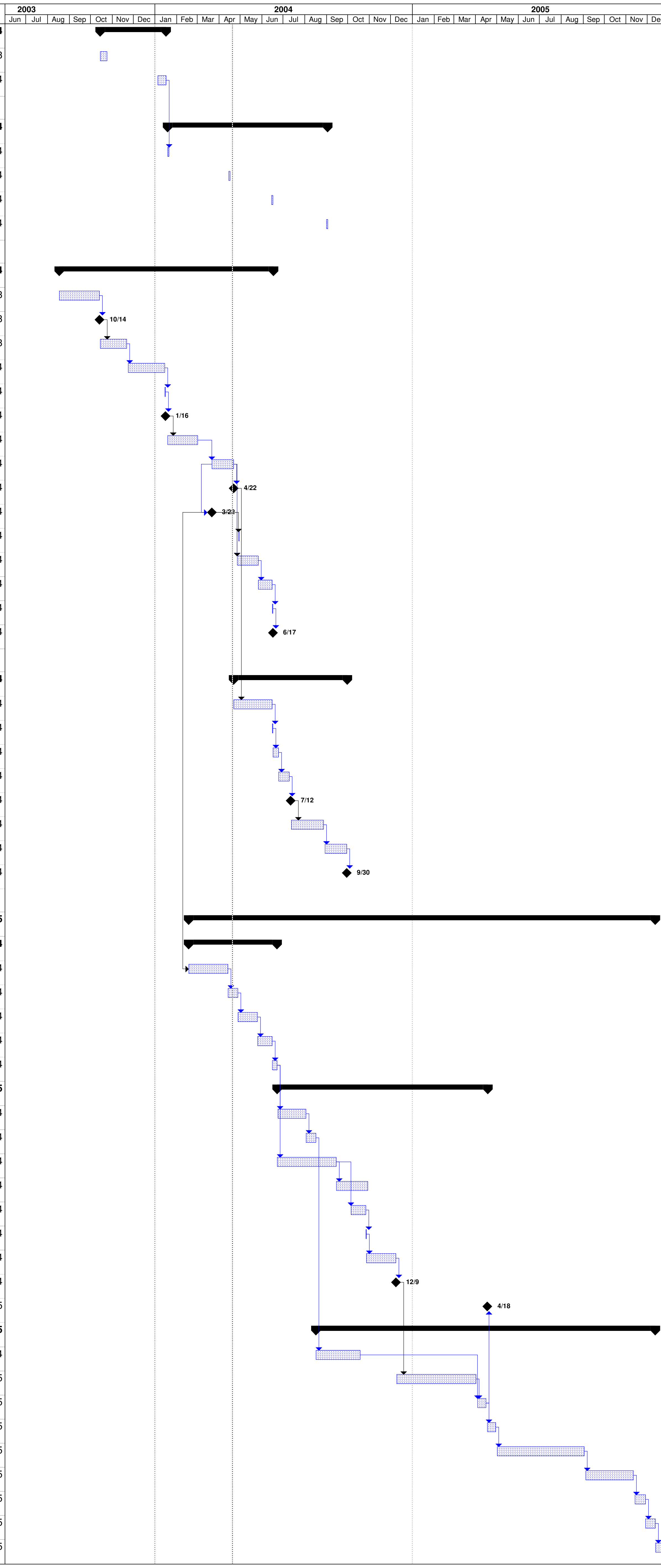


HILL AIR FORCE BASE
OPERABLE UNIT 12
ALTERNATIVE 1
AERATION CURTAIN
FIGURE 4-1

HILL AIR FORCE BASE OPERABLE UNIT 12 - ALTERNATIVE 1 AERATION CURTAIN

ID	Task Name	Start	Finish
1	**Site Investigation**	**Wed 10/15/03**	**Fri 1/16/04**
2	MWH Performs CPT Investigation at Abandoned Railroad Easement	Wed 10/15/03	Fri 10/24/03
3	MWH Installs Four Groundwater Monitoring Wells	Mon 1/5/04	Fri 1/16/04
4			
5	**Baseline Monitoring**	**Mon 1/19/04**	**Thu 9/2/04**
6	Sampling at Groundwater Monitoring Wells	Mon 1/19/04	Tue 1/20/04
7	Sampling at Groundwater Monitoring Wells	Thu 4/15/04	Fri 4/16/04
8	Sampling at Groundwater Monitoring Wells	Tue 6/15/04	Wed 6/16/04
9	Sampling at Groundwater Monitoring Wells	Wed 9/1/04	Thu 9/2/04
10			
11	**EE/CA Report**	**Mon 8/18/03**	**Thu 6/17/04**
12	MWH Prepares Internal Draft EE/CA	Mon 8/18/03	Mon 10/13/03
13	MWH submits Draft EE/CA to Hill AFB	Tue 10/14/03	Tue 10/14/03
14	Hill AFB Review Internal Draft EE/CA	Wed 10/15/03	Fri 11/21/03
15	MWH RTC and Prepare Draft EE/CA Report	Mon 11/24/03	Wed 1/14/04
16	MWH Submits Draft EE/CA Report to Hill AFB	Thu 1/15/04	Thu 1/15/04
17	Hill AFB Submits Draft EE/CA to Regulators	Fri 1/16/04	Fri 1/16/04
18	Regulatory Review of Draft EE/CA Report	Mon 1/19/04	Mon 3/1/04
19	MWH RTC to Regulatory Comments and Produce Final EE/CA	Mon 3/22/04	Wed 4/21/04
20	MWH Submits Final EE/CA to Hill AFB	Thu 4/22/04	Thu 4/22/04
21	Hill AFB Produce/mail Information Sheet to Residents	Mon 3/22/04	Thu 4/22/04
22	Public Meeting	Thu 4/29/04	Thu 4/29/04
23	30-Day Public Comment Period Begins	Tue 4/27/04	Wed 5/26/04
24	Hill AFB Compile Public Comments - MWH Support	Thu 5/27/04	Tue 6/15/04
25	Final Decision Meeting with Regulators	Wed 6/16/04	Wed 6/16/04
26	Hill AFB Notify Public of EE/CA Signing	Thu 6/17/04	Thu 6/17/04
27			
28	**Action Memorandum**	**Thu 4/22/04**	**Thu 9/30/04**
29	MWH Prepares Internal Draft Action Memo	Thu 4/22/04	Tue 6/15/04
30	MWH Submit Internal Draft Action Memo to Hill AFB	Wed 6/16/04	Wed 6/16/04
31	Hill AFB Review Internal Draft Action Memo	Thu 6/17/04	Thu 6/24/04
32	MWH Response to Comment and Prepare Draft Action Memo	Fri 6/25/04	Fri 7/9/04
33	MWH Submit Draft Action Memo to Hill AFB and Regulators	Mon 7/12/04	Mon 7/12/04
34	Regulator Review	Tue 7/13/04	Fri 8/27/04
35	MWH Response to Comments and Prepare Final Action Memo	Mon 8/30/04	Wed 9/29/04
36	Hill AFB Submit Final Action Memo To Regulators	Thu 9/30/04	Thu 9/30/04
37			
38	**Aeration Curtain Installation**	**Wed 2/18/04**	**Mon 12/12/05**
39	**Procurement**	**Wed 2/18/04**	**Tue 6/22/04**
40	Hill AFB Develops Design Build Scope of Work	Wed 2/18/04	Tue 4/13/04
41	Scope of Work Sent Out to Contractor Bid	Wed 4/14/04	Tue 4/27/04
42	Contractors Develop Pricing	Wed 4/28/04	Tue 5/25/04
43	Hill AFB Bid Evaluation	Wed 5/26/04	Tue 6/15/04
44	Hill AFB/Contractor Negotiation and Award	Wed 6/16/04	Tue 6/22/04
45	**Design**	**Wed 6/23/04**	**Mon 4/18/05**
46	Contractor Submittal preparation (RAWP, SSHP,SAP, CQCP, etc.)	Thu 6/24/04	Mon 8/2/04
47	Hill AFB Approval of Submittals	Tue 8/3/04	Mon 8/16/04
48	60% Design Preparation	Wed 6/23/04	Tue 9/14/04
49	60% Design Review (Hill AFB & Regulators)	Wed 9/15/04	Sat 10/30/04
50	Resolve Design Issues With Hill AFB and Regulators	Wed 10/6/04	Tue 10/26/04
51	One Day Meeting Onboard Comment Responses	Wed 10/27/04	Wed 10/27/04
52	100% Design Preparation	Thu 10/28/04	Wed 12/8/04
53	Submit 100% Design	Thu 12/9/04	Thu 12/9/04
54	Hill AFB Notify Public of Construction Start Date	Mon 4/18/05	Mon 4/18/05
55	**Construction**	**Tue 8/17/04**	**Mon 12/12/05**
56	Relocate Fiber Optic Line (3-Com)	Tue 8/17/04	Mon 10/18/04
57	Winter Weather Delay	Fri 12/10/04	Fri 4/1/05
58	Mobilize	Mon 4/4/05	Fri 4/15/05
59	Site Preparation	Mon 4/18/05	Fri 4/29/05
60	Construct Aeration Curtain	Mon 5/2/05	Fri 9/2/05
61	Utilities and Building Construciton	Mon 9/5/05	Fri 11/11/05
62	Monitoring Well Installation	Mon 11/14/05	Mon 11/28/05
63	Site Restoration	Tue 11/29/05	Mon 12/12/05
64	**Notify Public of Project Completion**	**Tue 12/13/05**	**Mon 12/26/05**



Project: FIGURE4-2AERATION.MPP
Date: Tue 4/20/04

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

FIGURE 4-2 PROPOSED EE/CA AERATION CURTAIN SCHEDULE

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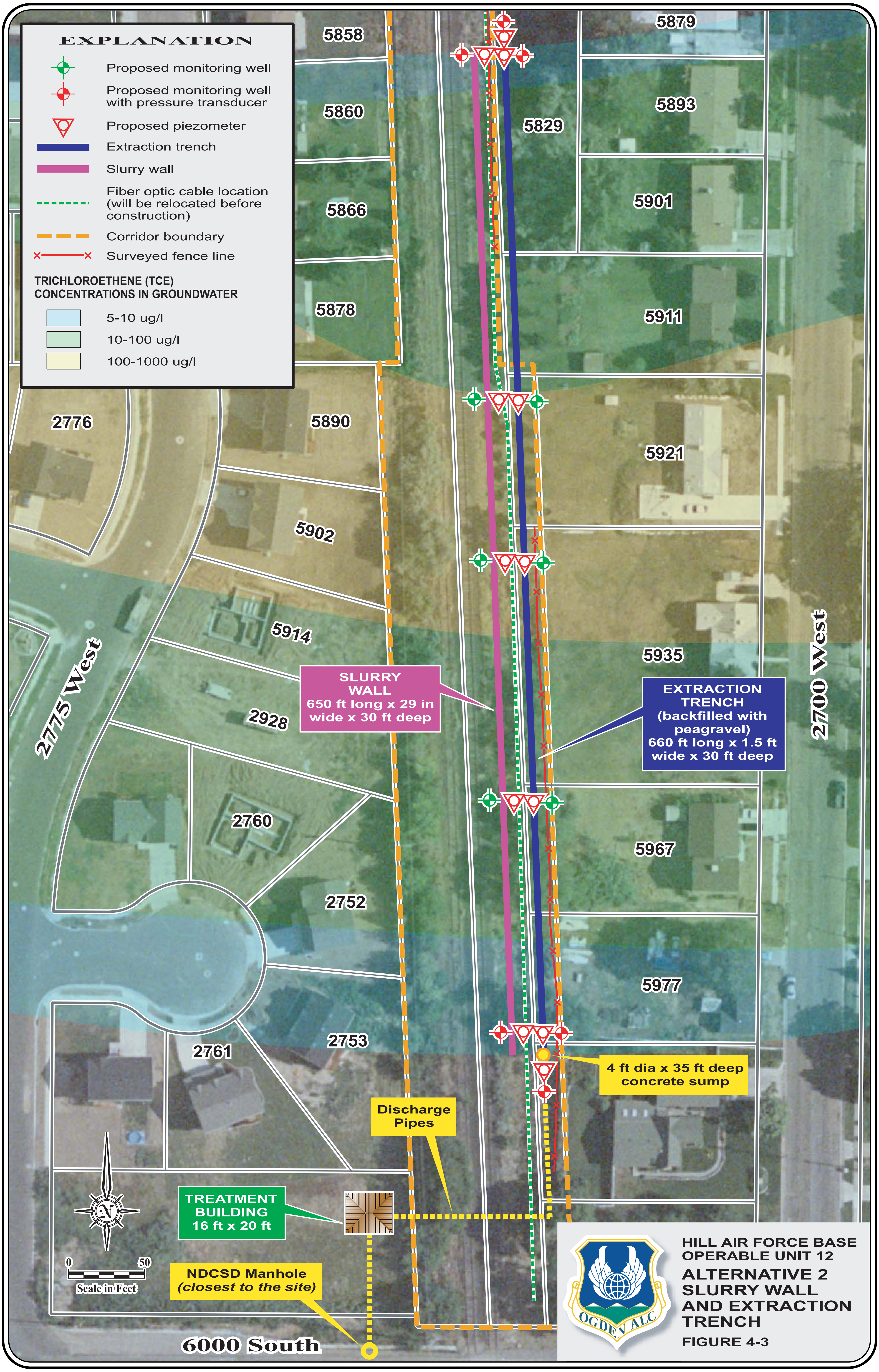

HILL AIR FORCE BASE
OPERABLE UNIT 12

ALTERNATIVE 2
SLURRY WALL
AND EXTRACTION
TRENCH

FIGURE 4-3

HILL AIR FORCE BASE OPERABLE UNIT 12 - ALTERNATIVE 2 SLURRY WALL AND EXTRACTION TRENCH

ID	Task Name	Start	Finish
1	**Site Investigation**	**Wed 10/15/03**	**Fri 1/16/04**
2	MWH Performs CPT Investigation at Abandoned Railroad Easement	Wed 10/15/03	Fri 10/24/03
3	MWH Installs Four Groundwater Monitoring Wells	Mon 1/5/04	Fri 1/16/04
4			
5	**Baseline Monitoring**	**Mon 1/19/04**	**Thu 9/2/04**
6	Sampling at Groundwater Monitoring Wells	Mon 1/19/04	Tue 1/20/04
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8	Sampling at Groundwater Monitoring Wells	Tue 6/15/04	Wed 6/16/04
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10			
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12	MWH Prepares Internal Draft EE/CA	Mon 8/18/03	Mon 10/13/03
13	MWH submits Draft EE/CA to Hill AFB	Tue 10/14/03	Tue 10/14/03
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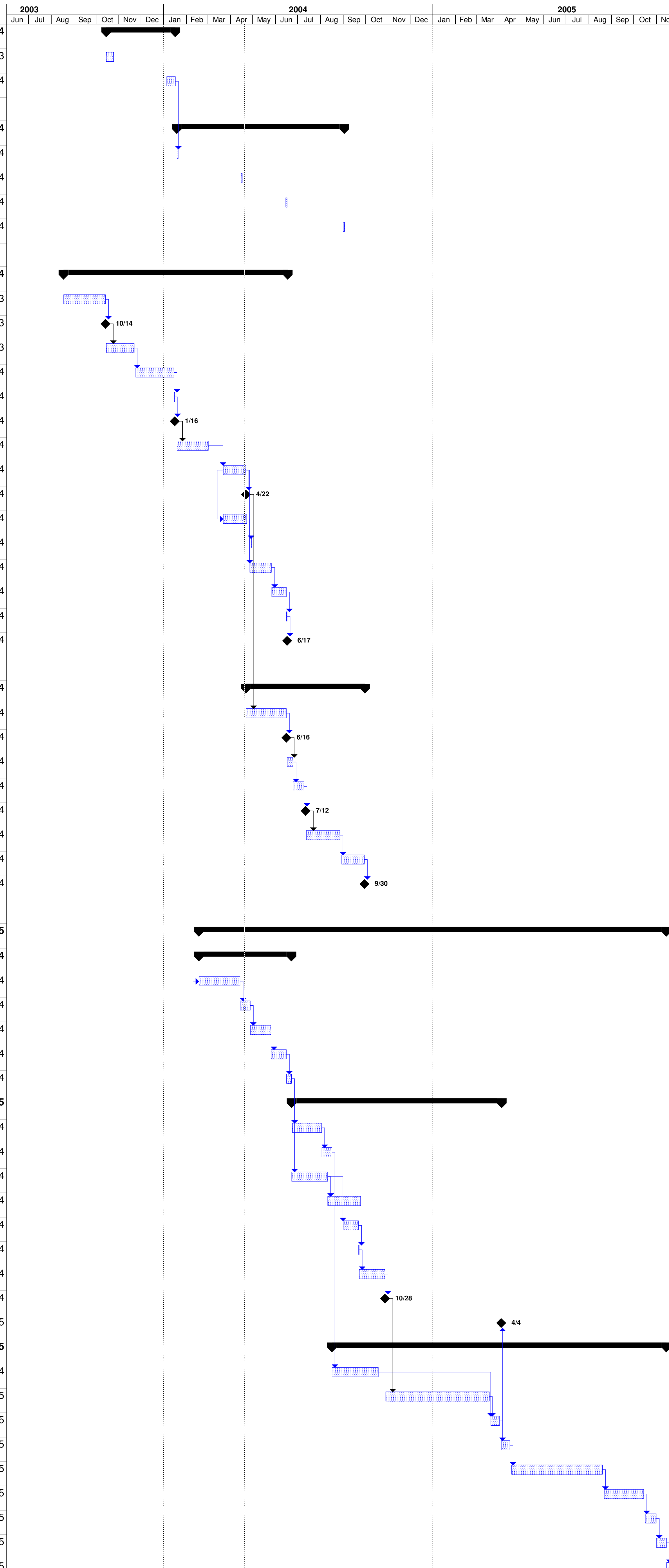
34	Regulator Review	Tue 7/13/04	Fri 8/27/04
35	MWH Response to Comments and Prepare Final Action Memo	Mon 8/30/04	Wed 9/29/04
36	Hill AFB Submit Final Action Memo To Regulators	Thu 9/30/04	Thu 9/30/04
37			
38	**SLURRY WALL AND EXTRACTION TRENCH**	**Wed 2/18/04**	**Mon 11/14/05**
39	**Procurement**	**Wed 2/18/04**	**Tue 6/22/04**
40	Hill AFB Develops Design Build Scope of Work	Wed 2/18/04	Tue 4/13/04
41	Scope of Work Sent Out to Contractor Bid	Wed 4/14/04	Tue 4/27/04
42	Contractors Develop Pricing	Wed 4/28/04	Tue 5/25/04
43	Hill AFB Bid Evaluation	Wed 5/26/04	Tue 6/15/04
44	Hill AFB/Contractor Negotiation and Award	Wed 6/16/04	Tue 6/22/04
45	**Design**	**Wed 6/23/04**	**Mon 4/4/05**
46	Contractor Submittal preparation (RAWP, SSHP,SAP, CQCP, etc.)	Thu 6/24/04	Mon 8/2/04
47	Hill AFB Approval of Submittals	Tue 8/3/04	Mon 8/16/04
48	60% Design Preparation	Wed 6/23/04	Tue 8/10/04
49	60% Design Review (Hill AFB & Regulators)	Wed 8/11/04	Sat 9/25/04
50	Resolve Design Issues With Hill AFB and Regulators	Wed 9/1/04	Tue 9/21/04
51	One Day Meeting Onboard Comment Responses	Wed 9/22/04	Wed 9/22/04
52	100% Design Preparation	Thu 9/23/04	Wed 10/27/04
53	Submit 100% Design	Thu 10/28/04	Thu 10/28/04
54	Hill AFB Notify Public of Construction Start Date	Mon 4/4/05	Mon 4/4/05
55	**Construction**	**Tue 8/17/04**	**Mon 11/14/05**
56	Relocate Fiber Optic Line (3-Com)	Tue 8/17/04	Mon 10/18/04
57	Winter Weather Delay	Fri 10/29/04	Fri 3/18/05
58	Mobilize	Mon 3/21/05	Fri 4/1/05
59	Site Preparation	Mon 4/4/05	Fri 4/15/05
60	Construct Slurry Wall and Extraction Trech	Mon 4/18/05	Fri 8/19/05
61	Utilities and Building Construciton	Mon 8/22/05	Fri 10/14/05
62	Monitoring Well Installation	Mon 10/17/05	Mon 10/31/05
63	Site Restoration	Tue 11/1/05	Mon 11/14/05
64	**Notify Public of Project Completion**	Tue 11/15/05	Mon 11/28/05



Project: FIGURE4-4EXTRENCH.MPP
Date: Tue 4/20/04

Task	Milestone	Rolled Up Task	Rolled Up Progress
Progress	Summary	Rolled Up Milestone	

FIGURE 4-4 PROPOSED EE/CA SLURRY WALL AND EXTRACTION TRENCH SCHEDULE

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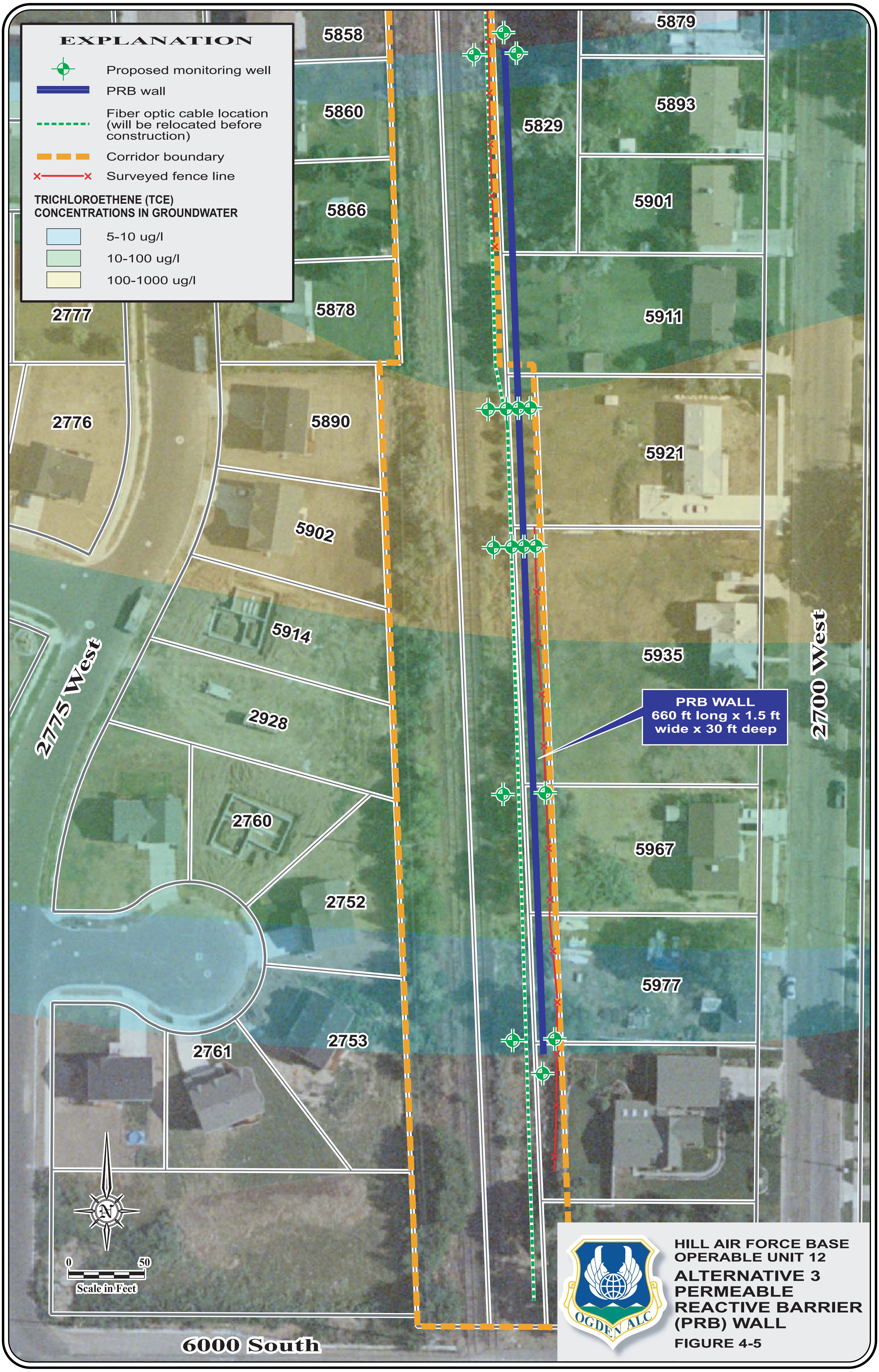
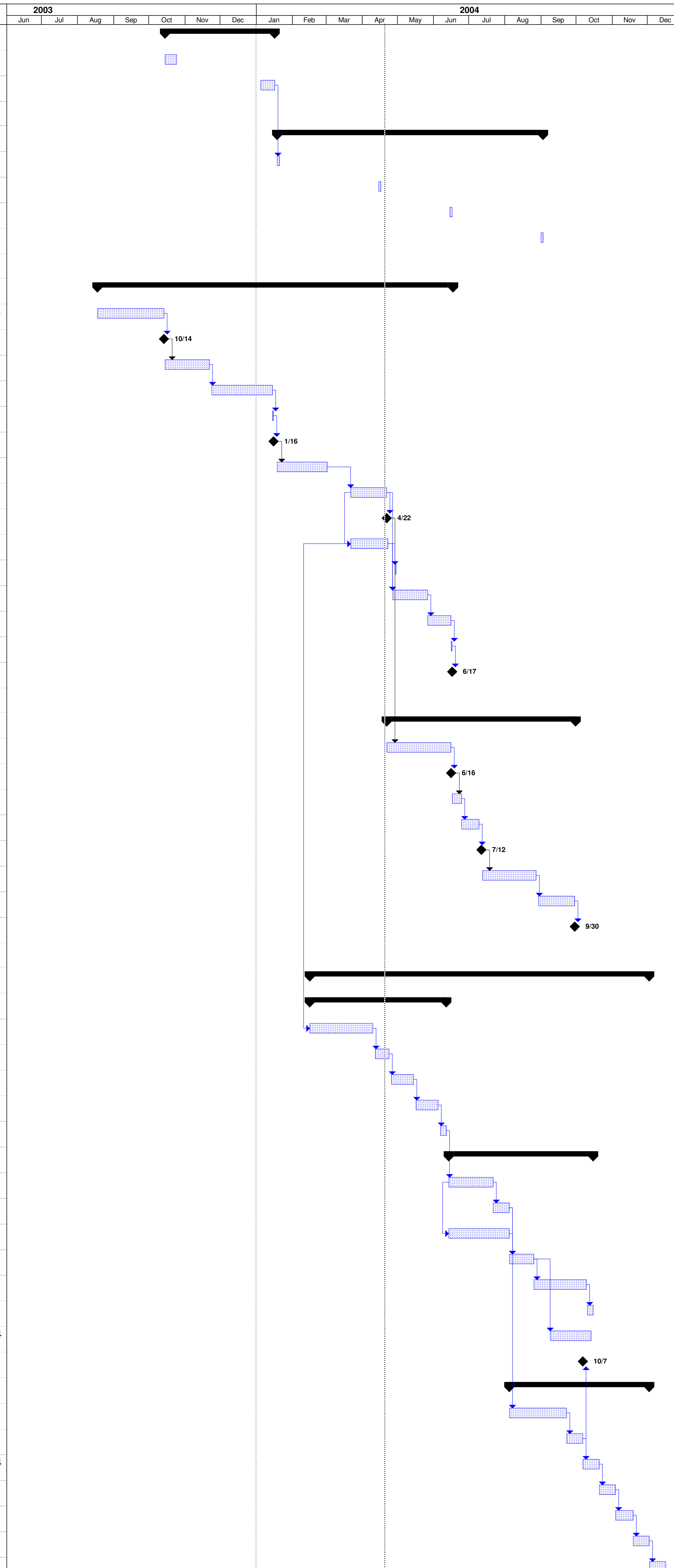


HILL AIR FORCE BASE
OPERABLE UNIT 12
ALTERNATIVE 3
PERMEABLE REACTIVE BARRIER (PRB) WALL
FIGURE 4-5

HILL AIR FORCE BASE OPERABLE UNIT 12 - ALTERNATIVIE 3 - PRB WALL

ID	Task Name	Start	Finish
1	**Site Investigation**	**Wed 10/15/03**	**Fri 1/16/04**
2	MWH Performs CPT Investigation at Abandoned Railroad Easement	Wed 10/15/03	Fri 10/24/03
3	MWH Installs Four Groundwater Monitoring Wells	Mon 1/5/04	Fri 1/16/04
4			
5	**Baseline Monitoring**	**Mon 1/19/04**	**Thu 9/2/04**
6	Sampling at Groundwater Monitoring Wells	Mon 1/19/04	Tue 1/20/04
7	Sampling at Groundwater Monitoring Wells	Thu 4/15/04	Fri 4/16/04
8	Sampling at Groundwater Monitoring Wells	Tue 6/15/04	Wed 6/16/04
9	Sampling at Groundwater Monitoring Wells	Wed 9/1/04	Thu 9/2/04
10			
11	**EE/CA Report**	**Mon 8/18/03**	**Thu 6/17/04**
12	MWH Prepares Internal Draft EE/CA	Mon 8/18/03	Mon 10/13/03
13	MWH submits Draft EE/CA to Hill AFB	Tue 10/14/03	Tue 10/14/03
14	Hill AFB Review Internal Draft EE/CA	Wed 10/15/03	Fri 11/21/03
15	MWH RTC and Prepare Draft EE/CA Report	Mon 11/24/03	Wed 1/14/04
16	MWH Submits Draft EE/CA Report to Hill AFB	Thu 1/15/04	Thu 1/15/04
17	Hill AFB Submits Draft EE/CA to Regulators	Fri 1/16/04	Fri 1/16/04
18	Regulatory Review of Draft EE/CA Report	Mon 1/19/04	Mon 3/1/04
19	MWH RTC to Regulatory Comments and Produce Final EE/CA	Mon 3/22/04	Wed 4/21/04
20	MWH Submits Final EE/CA to Hill AFB	Thu 4/22/04	Thu 4/22/04
21	Hill AFB Produce/mail Information Sheet to Residents	Mon 3/22/04	Thu 4/22/04
22	Public Meeting	Thu 4/29/04	Thu 4/29/04
23	30-Day Public Comment Period Begins	Tue 4/27/04	Wed 5/26/04
24	Hill AFB Compile Public Comments - MWH Support	Thu 5/27/04	Tue 6/15/04
25	Final Decision Meeting with Regulators	Wed 6/16/04	Wed 6/16/04
26	Hill AFB Notify Public of EE/CA Signing	Thu 6/17/04	Thu 6/17/04
27			
28	**Action Memorandum**	**Thu 4/22/04**	**Thu 9/30/04**
29	MWH Prepares Internal Draft Action Memo	Thu 4/22/04	Tue 6/15/04
30	MWH Submit Internal Draft Action Memo to Hill AFB	Wed 6/16/04	Wed 6/16/04
31	Hill AFB Review Internal Draft Action Memo	Thu 6/17/04	Thu 6/24/04
32	MWH Response to Comment and Prepare Draft Action Memo	Fri 6/25/04	Fri 7/9/04
33	MWH Submit Draft Action Memo to Hill AFB and Regulators	Mon 7/12/04	Mon 7/12/04
34	Regulator Review	Tue 7/13/04	Fri 8/27/04
35	MWH Response to Comments and Prepare Final Action Memo	Mon 8/30/04	Wed 9/29/04
36	Hill AFB Submit Final Action Memo To Regulators	Thu 9/30/04	Thu 9/30/04
37			
38	**PRB Wall Installation**	**Mon 2/16/04**	**Thu 12/2/04**
39	**Procurement**	**Mon 2/16/04**	**Fri 6/11/04**
40	Hill AFB Develops Design Build Scope of Work	Mon 2/16/04	Fri 4/9/04
41	Scope of Work Sent Out to Contractor Bid	Mon 4/12/04	Fri 4/23/04
42	Contractors Develop Pricing	Mon 4/26/04	Fri 5/14/04
43	Hill AFB Bid Evaluation	Mon 5/17/04	Fri 6/4/04
44	Hill AFB/Contractor Negotiation and Award	Mon 6/7/04	Fri 6/11/04
45	**Design**	**Mon 6/14/04**	**Fri 10/15/04**
46	Contractor Submittal preparation (RAWP, SSHP,SAP, CQCP, etc.)	Mon 6/14/04	Wed 7/21/04
47	Hill AFB Approval of Submittals	Thu 7/22/04	Wed 8/4/04
48	Bench-scale Confirmation Sand/Iron Mix	Mon 6/14/04	Wed 8/4/04
49	Complete Design Detail	Thu 8/5/04	Wed 8/25/04
50	Review (Hill AFB and Regulators)	Thu 8/26/04	Sun 10/10/04
51	Contractor Finalize Design	Mon 10/11/04	Fri 10/15/04
52	Compile Project Implementation Plan	Thu 9/9/04	Wed 10/13/04
53	Hill AFB Notify Public of Construction Start Date	Thu 10/7/04	Thu 10/7/04
54	**Construction**	**Thu 8/5/04**	**Thu 12/2/04**
55	Relocate Fiber Optic Line (3-Com)	Thu 8/5/04	Wed 9/22/04
56	Mobilize	Thu 9/23/04	Wed 10/6/04
57	Site Preparation	Thu 10/7/04	Wed 10/20/04
58	PRB Installation	Thu 10/21/04	Wed 11/3/04
59	Monitoring Well Installation	Thu 11/4/04	Thu 11/18/04
60	Site Restoration	Fri 11/19/04	Thu 12/2/04
61	**Notify Public of Project Completion**	Fri 12/3/04	Thu 12/16/04



Project: FIGURE4-6PRB.MPP
Date: Tue 4/20/04

Task	Milestone	Rolled Up Task	Rolled Up Progress
Progress	Summary	Rolled Up Milestone	

FIGURE 4-6 PROPOSED EE/CA PRB WALL SCHEDULE

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES AND CONCLUSIONS

5.0.0.1. This section presents a comparative analysis of the three removal action alternatives considered in this EE/CA to evaluate the relative performance of each alternative in relation to each of the three main criteria (effectiveness, implementability, and cost). Based on the comparative analysis, one of the removal action alternatives is recommended for implementation.

5.1 COMPARATIVE ANALYSIS

5.1.0.1. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect the remedy selection can be identified. Table 5-1 presents the comparative analysis of the three proposed alternatives with respect to the evaluation criteria. A graded measurement scale is used to rank each alternative at its effectiveness in meeting the criteria. The three scales of measurement are “fully meets criteria,” “partially meets criteria,” and “does not meet criteria.”

5.1.1 Effectiveness

5.1.1.1. As shown in Table 5-1, all three alternatives comply fully with the effectiveness criteria. They also comply fully with long-term effectiveness and permanence and reduction of toxicity, mobility, or volume through treatment criteria. However, the PRB Wall (Alternative 3) is considered superior to the other two alternatives in that it achieves reduction of toxicity with in-situ treatment without any disruption to natural groundwater flow. The Slurry Wall and Extraction Trench (Alternative 2) requires that groundwater be extracted and treated at the POTW. The groundwater is therefore lost for beneficial use. The Aeration Curtain (Alternative 1) achieves reduction in toxicity by transferring the contaminants from groundwater to the vadose zone for subsequent extraction and discharge to the atmosphere, but may have noise considerations in a residential neighborhood. With respect to short-term effectiveness, all three alternatives only partially meet the criteria due to the probability of risk, however minimal, to community, workers, and the environment during the implementation stage of the alternatives.

5.1.2 Implementability

5.1.2.1. Only the Slurry Wall with Extraction Trench (Alternative 2) and the PRB Wall (Alternative 3) comply fully with the implementability criteria. Due to the complexity involved in construction of the Aeration Curtain (Alternative 1), it only partially meets the criteria in comparison to the other two alternatives. Construction of the Aeration Curtain is much more difficult because of the shallow depth to groundwater, which complicates trench construction using biopolymer slurry and requires additional earthen berm support above grade to retain the slurry. This could result in additional time on site for construction and associated disruption to the community compared to the other alternatives. The Slurry Wall and Extraction Trench option requires two separate trenches in which the Slurry Wall would be located at the approximate center line of the property. This may pose a settlement concern due to consolidation and settlement of the trench media in the future if the railroad becomes active again. However, the PRB Wall is considered more advantageous than the other alternatives since the construction site can be easily restored to original conditions allowing for subsequent use of the property with minimum surface disruptions (such as monitoring wells and trench markers). For these reasons the PRB Wall also complies with RAO #3 better than the other alternatives.

5.1.3 Cost

5.1.3.1. In terms of cost, Alternative 1 is most expensive with a total direct cost of $2,289,841 (-30%/+50%) and a 30-year present worth of $6,271,000 (-30%/+50%). Alternative 2 is the second most expensive with a total direct cost of $1,497,702 (-30%/+50%) and a 30-year present worth of $4,070,000 (-30%/+50%). Alternative 3 is the least costly with a total direct cost of $1,529,958 (-30%/+50%) and a 30-year present worth of $2,356,000 (-30%/+50%). The main difference in 30-year present worth costs is related to annual operation and maintenance costs differences between systems.

5.1.4 State and Community Acceptance

5.1.4.1. Because the State and the local community have yet to be apprised of the proposed removal action at the railroad corridor site in the form of the Action Memorandum, the State and community acceptance criteria are undetermined at the present time.

5.2 RECOMMENDED REMOVAL ACTION ALTERNATIVE

5.2.0.1. Based on the detailed and comparative analysis of the three proposed alternatives, Alternative 3 (the PRB Wall) is chosen as the recommended alternative. In summary, the following reasons were critical in making this determination:

- Alternative 3 presents the remedy to achieve all the RAOs most effectively.

- Construction of Alternative 3 is expected to require the least amount of time during which the community, site workers, and the environment may be exposed to minimal risks and disruptions.

- Once implemented, Alternative 3 would require the least attention in maintaining and operating the system.

- Once implemented, the project site could be restored to its original state with minimum features left above ground (such as monitoring well points). Hence the inactive railroad could also be activated, if required, at a future date.

- Due to the passive nature of the PRB Wall, no discharges or wastes are generated during the operation of the system that would require disposal.

- Although the direct capital costs of the PRB Wall are higher than that of Alternative 2 (the combination extraction trench and slurry wall), substantial cost savings are seen in the lower O&M costs for the PRB Wall to make it the most economical of the considered remedies.

TABLE 5-1

COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES
OPERABLE UNIT 12
HILL AIR FORCE BASE, UTAH

CRITERIA CATEGORY	EVALUATION CRITERIA	ALTERNATIVE 1 Aeration Curtain	ALTERNATIVE 2 Slurry Wall and Extraction Trench	ALTERNATIVE 3 Permeable Reactive Barrier (PRB)Wall
Threshold Criteria	1. Overall protection of human health and the environment	Fully meets criteria	Fully meets criteria	Fully meets criteria
	2. Compliance with ARARs	Fully meets criteria	Fully meets criteria	Fully meets criteria
Primary Balancing Criteria	3. Long-term effectiveness and performance	Fully meets criteria	Fully meets criteria	Fully meets criteria
	4. Reduction of toxicity, mobility, or volume through treatment	Fully meets criteria	Fully meets criteria	Fully meets criteria
	5. Short-term effectiveness	Partially meets criteria	Partially meets criteria	Partially meets criteria
	6. Implementability	Partially meets criteria	Fully meets criteria	Fully meets criteria
	7. Cost (-30% / +50%)	$4,389,700 to $9,406,500	$2,849,000 to $6,105,000	$1,649,200 to $3,534,000
Modifying Criteria	8. Community acceptance	To be determined	To be determined	To be determined
	9. State acceptance	To be determined	To be determined	To be determined

Fully meets criteria *Partially meets criteria* *To be determined* *Does not meet criteria*

REFERENCES

Feth, J.H., Barker, D. A., Moore, L. G., Brown, R. J., and Veirs, C.E., 1966. *Lake Bonneville: Geology and Hydrology of the Weber Delta District including Ogden, Utah.* U.S. Geological Survey Professional Paper 518.

Montgomery Watson, 2000. *Final Remedial Investigation/Feasibility Study Work Plans for Operable Units 5 and 9*, Hill Air Force Base, Utah, May 2000.

MWH, 2002a. *Environmental Restoration Management Action Plan - 2001,* Hill Air Force Base, Utah, September 2002.

MWH, 2002b. *Final Operable Unit 5 and 12 Historic Site and Source Area Review*, Hill Air Force Base, Utah, March 2002.

MWH, 2002c. *Final Operable Unit 12 Base Boundary Hydraulic Containment System Treatability Study Work Plan*, Hill Air Force Base, Utah, August 2002.

MWH, 2003a. *Internal Draft Remedial Investigation Report for Operable Unit 12*, Hill Air Force Base, Utah, May 2003.

MWH, 2003b. *Final Action Memorandum for Time-Critical Removal Actions for Indoor Air*, Hill Air Force Base, Utah, September 2003.

MWH, 2004. *Final Basewide Air Sampling and Analysis Plan: Indoor Residential Air Sampling*, Hill Air Force Base, Utah, January 2004.

U.S. Geological Survey (USGS), 1988. *Draft Literature Search - Landfills 1 and 2 - Hill Air Force Base, Utah. USAF Occupational & Environmental Health Laboratory, Technical Services Division.* Brooks Air Force Base, Texas. 1988.

APPENDIX A

GROUNDWATER FLOW AND CONTAMINANT TRANSPORT MODEL

A1.0 INTRODUCTION

A1.0.0.1. Groundwater flow and contaminant transport modeling was performed to assist in the evaluation of the alternatives for a removal action at Operable Unit (OU) 12. The purpose of the removal action is to contain trichloroethene (TCE) contaminated groundwater where the OU 12 TCE plume crosses the railroad corridor property, between 2700 West and 2775 West in the City of Roy. The dissolved-phase TCE plume, as defined by the MCL for TCE (5 μg/l) is approximately 660 feet wide and extends to a depth of 30 feet below ground surface where it crosses beneath the railroad corridor property. The maximum TCE concentration in the area is estimated to be 200 μg/l. Significantly higher contaminant concentrations (e.g., 1,000 μg/l) are not expected to reach the railroad corridor property. The objective of the action is to limit further migration of groundwater with TCE concentrations greater than the MCL (i.e., 5 micrograms per liter [μg/l]). Alternatives evaluated with the groundwater model for this removal action include:

- Alternative 1 - Aeration Curtain
- Alternative 2 - Slurry Wall and Extraction Trench
- Alternative 3 - Permeable Reactive Barrier (PRB) Wall.

A1.0.0.2. This appendix documents the modeling that was performed to assist in the evaluation of the alternatives for the removal action proposed for OU 12. The methodologies used to simulate these containment alternatives are described in Section A2.0. Results of the simulations are provided in Section A3.0. Figures illustrating the predicted TCE plume configurations through time are provided for each alternative in this section. A summary of the modeling is provided in Section A4.0.

A2.0 METHODOLOGY

A2.0.0.1. The groundwater flow and contaminant transport codes MODFLOW, MODPATH, and MT3D were used with the pre- and post-processor GMS for this modeling. The methodologies used to construct and calibrate the OU 12 groundwater flow and contaminant transport model are documented in the *Operable Unit 12 Addendum to the Groundwater Flow and Contaminant Transport Model Report for Operable Unit 5* (MWH, 2002a), the *Final Groundwater Flow Model Report for Operable Unit 5* (Montgomery Watson Harza, 2001), and the *Final Contaminant Transport Model Report for Operable Unit 5* (MWH, 2002b). These documents are available in the appendices of the *Draft Remedial Investigation Report for Operable Unit 12* (MWH, 2003). Further modifications that were made to the OU 12 model for the removal alternatives evaluation are described below.

A2.1 PREDICTIVE SIMULATIONS

A2.1.0.1. The model was used to predict effectiveness (for TCE contaminated groundwater) for each containment alternative and to estimate flow rates and drawdown for the alternatives. Contaminant transport simulations for all predictive simulations were run for a period of 30 years into the future from the present (2003). Because TCE is the most widespread contaminant at OU 12, it was the only contaminant simulated. The initial conditions (TCE distribution and concentrations) used in the simulations were the same in all simulations and are the results (output) of the plume-matching simulations rather than actual data. For this reason, the TCE plume is slightly south of its actual position by approximately 100 feet. The deviations from actual conditions are not expected to have an impact on the evaluation. While the removal action alternatives are simulated to contain the plume as it is simulated, actual systems should be installed to intersect the plume in its actual position as determined through pre-design field investigations.

A2.1.0.2. The OU 12 Base Boundary Hydraulic Containment System was assumed to remain in operation in the predictive simulations for all alternatives. The purpose of this system is to control the source, specifically by containing all groundwater with TCE concentrations greater than 100 μg/l at the Base boundary. This system will be decommissioned only if the source is removed, destroyed, or controlled in some other way. Operation of this system has been erratic due to problems with the power supply. Of the six months that the system has been in operation, it was the most stable in July 2003. Based on pumping data from July 2003, it appears that the long-term sustainable discharge rate for this system is approximately 17.0 gallons per minute (gpm; 4.0, 8.4, and 4.6 gpm from U12-201, U12-202, and U12-203, respectively). These discharge rates were included in all predictive simulations for the alternatives analysis. If in the future, discharge rates are increased to contain groundwater with TCE concentrations between 5 and 100 μg/l, then the model can be rerun with the higher pumping rates to reflect these conditions more accurately.

A2.1.1 Aeration Curtain

The Aeration Curtain was modeled to be 660 feet long, extending across the TCE plume to encompass the entire plume defined by the 5 μg/l contour on the railroad corridor property. The Aeration Curtain was modeled to extend through layers 1 and 2 of the model (approximately 30 feet deep in this area). The hydraulic conductivity was assumed to be 140 feet/day, given that the trench will be backfilled with pea gravel. First-order degradation was used to simulate TCE mass loss through air sparging. It was assumed that the aeration curtain would reduce TCE concentrations to below the MCL.

A2.1.2 Slurry Wall and Extraction Trench

The Slurry Wall and Extraction Trench Alternative was modeled to be 660 feet long, extending across the TCE plume to encompass the entire plume defined by the 5 μg/l contour on the railroad corridor property. The gradient control extraction trench was located immediately upgradient of the slurry wall. The extraction trench was used to control the hydraulic gradient and prevent water from mounding on the upgradient side of the slurry wall and to prevent water from migrating beneath, through, and around the ends of the wall. The extraction trench was simulated with the Drain package in MODFLOW. The slurry wall was modeled using the MODFLOW horizontal flow barrier (HFB) package. This barrier was given a horizontal hydraulic conductivity of 1.0×10^{-7} cm/sec (3×10^{-4} feet/day), typical of a bentonite slurry wall, and a thickness of 29 inches (values provided by DeWind Dewatering, Holland, Michigan). While the trench extended through layers 1 and 2, the slurry wall extended through layers 1, 2, and 3, in order to simulate the wall being keyed into the underlying low permeability unit. To maintain complete containment, drawdown was set at 1.6 feet in the extraction trench, which resulted in a discharge rate of 33 gpm.

A2.1.3 Permeable Reactive Barrier Wall

A2.1.3.1. The PRB Wall Alternative was modeled to be 660 feet long, extending across the TCE plume to encompass the entire plume defined by the 5 μg/l contour on the railroad corridor property. The model grid was refined to a 2-foot spacing in the railroad corridor property for more accurate simulation of this alternative. The PRB wall was modeled to be 2 feet wide and to extend through layers 1 and 2 (approximately 30 feet deep in this area). TCE mass loss through reduction with zero-valent iron in the PRB Wall Alternative was simulated with first-order degradation. Based on literature reported values for TCE reduction with zero-valent iron, a degradation rate of 10 day^{-1} was used, which is equivalent to a half-life of 2 hours. Given that the PRB wall will consist of a mixture of shredded iron and coarse sand, the hydraulic conductivity of the PRB wall was assumed to be 140 feet/day.

A3.0 RESULTS

A3.0.01. Results of the predictive simulations for the three alternatives are described below. All alternatives assume continued operation of the Base Boundary Hydraulic Containment System. Results of the contaminant transport modeling of TCE is described for each alternative after 10, 20, and 30 years of operation (into the future).

A3.1 AERATION CURTAIN

A3.1.0.1. The model-predicted TCE plumes through time under the Aeration Curtain Alternative are shown in Figure A3-1. The top frame represents the current TCE plume configuration prior to system startup. The model predicts that the aeration curtain will completely contain the plume at the railroad corridor property. Below this are the model-predicted TCE plumes after the system has been in operation for 10, 20, and 30 years. Contamination that is initially downgradient of the aeration curtain will continue to migrate downgradient to the west. This contamination becomes an isolated slug that continues to migrate westward, disperse, and degrade through time. It should be noted that the hydrogeology downgradient (west) of the current plume configuration is largely unknown and was extrapolated for this modeling effort. For this reason, little confidence should be given to the northern component of the isolated plume's migration as it travels 2,000 to 4,000 feet beyond its current position.

A3.1.0.2. The Base Boundary Hydraulic Containment System is predicted to contain contaminated groundwater with TCE concentrations above 100 μg/l. This reduces influent contaminant concentrations at the Aeration Curtain to concentrations below 100 μg/l in approximately 35 years. However, groundwater with TCE concentrations above the MCL are predicted to reach the site of the railroad corridor property indefinitely, as long as there is an ongoing source. Thus the aeration curtain will have to be operated indefinitely. Fortunately, modeling predicts that the high concentration (e.g., 1,000 μg/l) portion of the plume is stable and will not migrate to the site of the proposed Aeration Curtain, thus it will not have to treat high contaminant concentrations.

A3.2 SLURRY WALL AND EXTRACTION TRENCH

A3.2.0.1. The extraction trench is predicted to need to be pumped at a rate of 33 gpm, which results in 1.6 feet of drawdown in the trench in order to achieve complete containment of the TCE plume at the railroad corridor property. The model-predicted TCE plumes through time under the Slurry Wall and Extraction Trench Alternative are shown in Figure A3-2. The model predicts that the slurry wall and extraction trench will completely contain the TCE plume at the railroad corridor property, although the model results appear to contradict this, as described below. The contaminant transport modeling results indicate that some contamination continues to get past the system. However, this is contamination that was downgradient of the system prior to operation of the system. Contamination that is initially downgradient of the slurry wall will continue to migrate downgradient to the west. Unlike in aeration curtain alternative, this contamination does not become an isolated slug that continues to migrate westward. There is a stagnation zone immediately downgradient of the slurry wall, which is slowly flushed. This results in residual contamination that is slowly flushed away from the downgradient side of the slurry wall and is the cause of the low concentration plume that remains downgradient of the system. As with the previous alternative, little confidence should be given to the northern component of the plume's migration as it travels 2,000 to 4,000 feet beyond its current position.

A3.2.0.2. The Base Boundary Hydraulic Containment System is predicted to contain contaminated groundwater with TCE concentrations above 100 μg/l. This reduces influent contaminant concentrations at the extraction trench to concentrations below 100 μg/l in approximately 35 years. However, groundwater with TCE concentrations above the MCL are predicted to reach the site of the railroad corridor property indefinitely, as long as there is an ongoing source. Thus the slurry wall and extraction trench system will have to be operated indefinitely.

A3.3 PERMEABLE REACTIVE BARRIER WALL

A3.3.0.1. The model-predicted TCE plumes through time under the PRB Wall Alternative are shown in Figure A3-3. The model predicts that the PRB wall will completely contain the TCE plume at the railroad corridor property. Contamination that is initially downgradient of the PRB wall will continue to migrate downgradient to the west. This contamination becomes an isolated slug that continues to migrate westward, disperse, and degrade through time. As with the other alternatives, little confidence should be given to the northern component of the isolated plume's migration as it travels 2,000 to 4,000 feet beyond its current position.

A3.3.0.2. The Base Boundary Hydraulic Containment System is predicted to contain contaminated groundwater with TCE concentrations above 100 μg/l. This reduces influent contaminant concentrations at the PRB wall to concentrations below 100 μg/l in approximately 35 years. However, groundwater with TCE concentrations above the MCL are predicted to reach the site of the railroad corridor property indefinitely, as long as there is an ongoing source. Thus the PRB wall will have to be maintained indefinitely. Fortunately, modeling predicts that the high concentration (e.g., 1,000 μg/l) portion of the plume is stable and will not migrate to the site of the proposed PRB wall, thus it will not have to treat high contaminant concentrations.

A4.0 SUMMARY OF PREDICTIVE SIMULATIONS

A4.0.0.1. Groundwater flow and contaminant transport modeling was performed to assist in evaluating the alternatives for the removal action planned for the railroad corridor property between 2700 West and 2775 West in Roy. Modeling indicates that all three alternatives will contain TCE contaminated groundwater at the railroad corridor property. Containment will be immediate once operation of the systems begins. However, contamination that is downgradient of the systems initially will continue to migrate westward. Because the Aeration Curtain Alternative and PRB Wall Alternative both treat the water in situ, groundwater downgradient of these system is remediated and downgradient contamination migrates as an isolated slug. Because the slurry wall and extraction trench form a stagnation zone downgradient of the slurry wall, low levels of contamination remain on the downgradient side of the system. All alternatives assume that the Base Boundary Hydraulic Containment System contains contaminated groundwater with TCE concentrations above 100 μg/l, which reduces influent contaminant concentrations at the railroad corridor property to concentrations below 100 μg/l in approximately 35 years. Because groundwater with TCE concentrations above the MCL are predicted to reach the site of the railroad corridor property indefinitely, the system at the railroad corridor property will have to be operated indefinitely.

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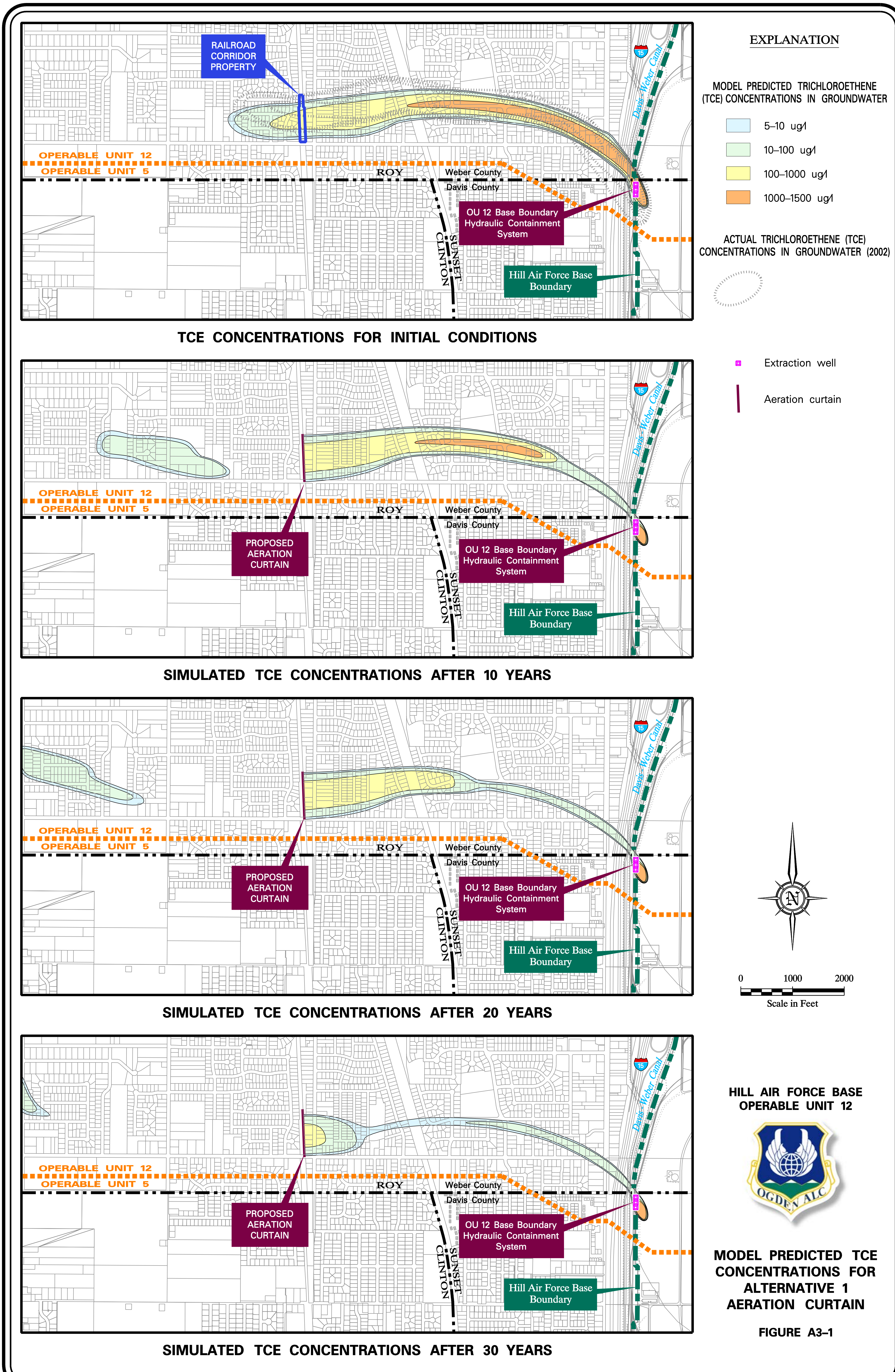

MODEL PREDICTED TCE CONCENTRATIONS FOR ALTERNATIVE 1 AERATION CURTAIN

FIGURE A3–1

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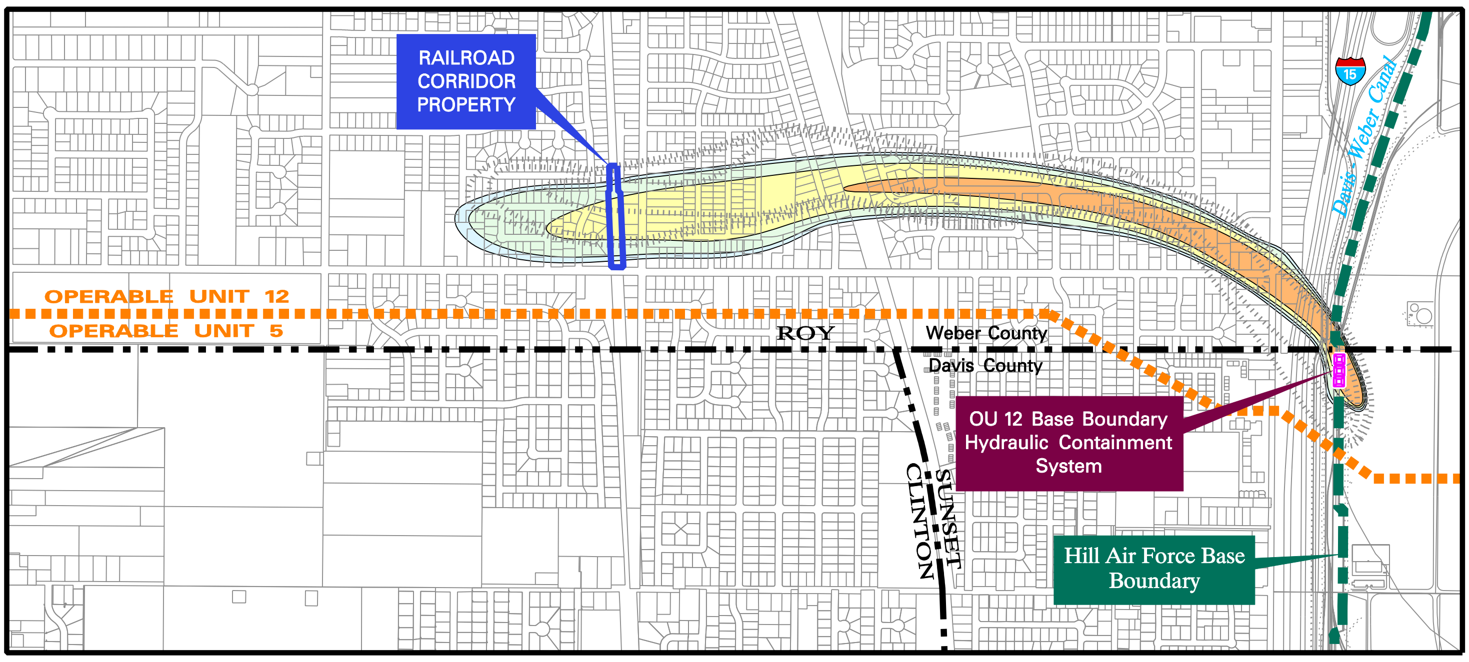
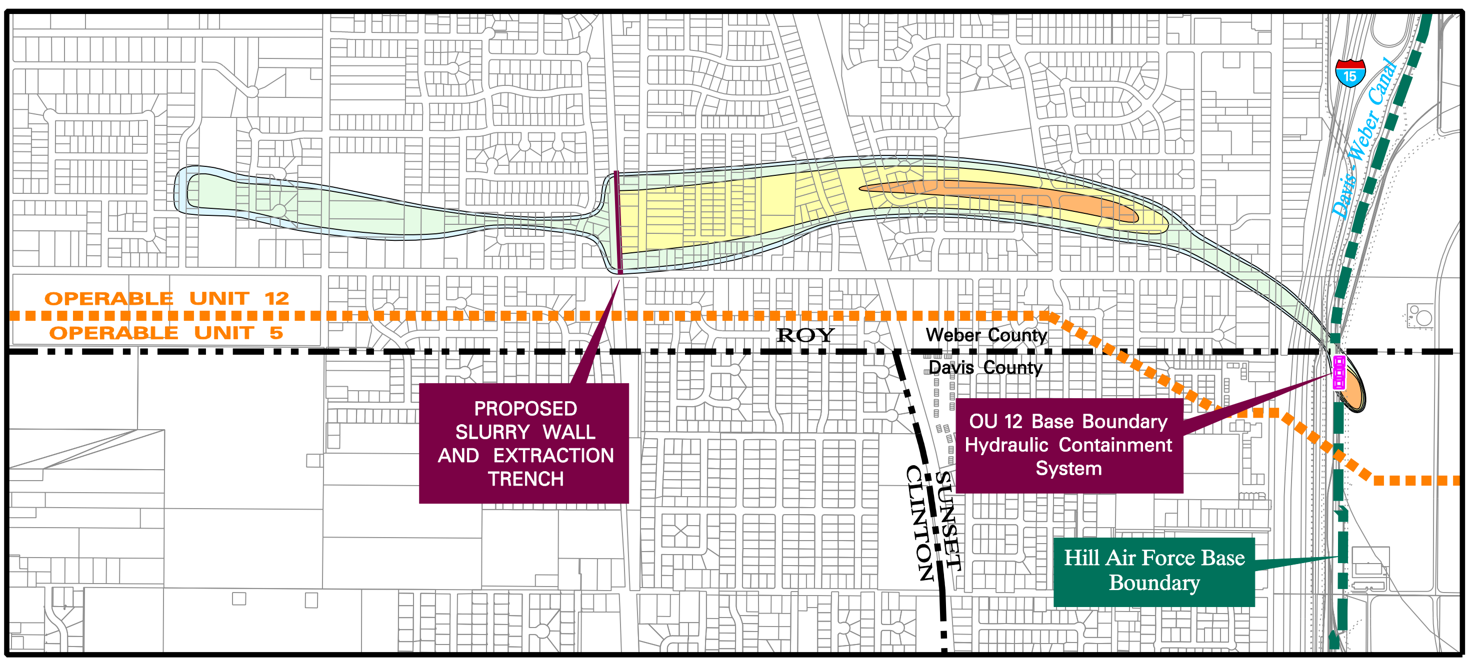
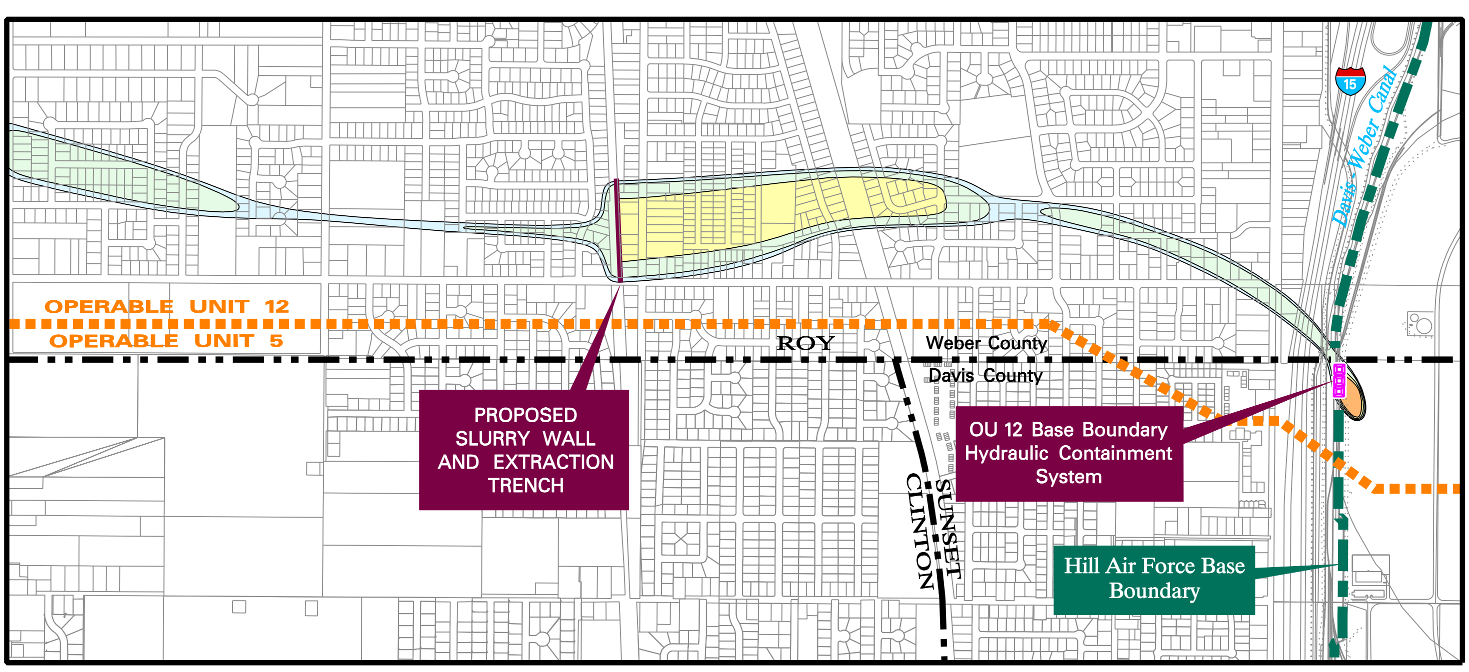


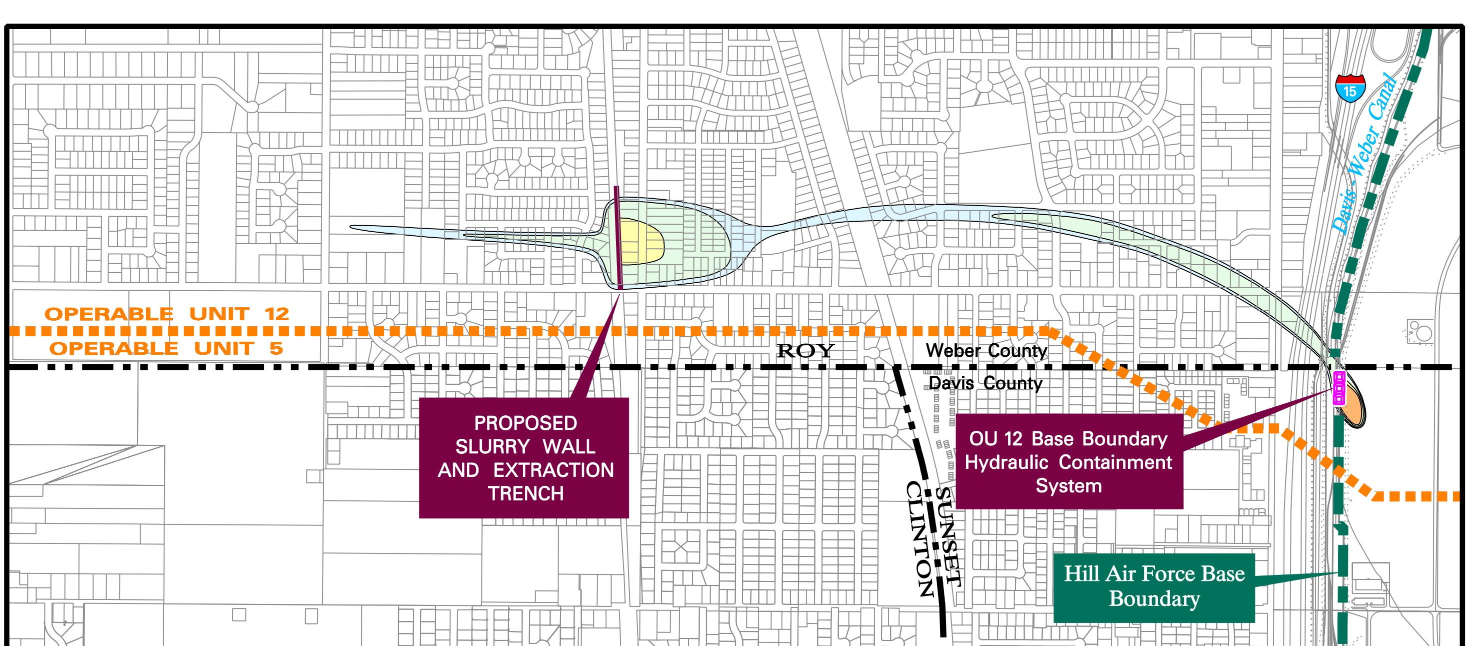
TCE CONCENTRATIONS FOR INITIAL CONDITIONS



SIMULATED TCE CONCENTRATIONS AFTER 10 YEARS



SIMULATED TCE CONCENTRATIONS AFTER 20 YEARS



SIMULATED TCE CONCENTRATIONS AFTER 30 YEARS

EXPLANATION

MODEL PREDICTED TRICHLOROETHENE (TCE) CONCENTRATIONS IN GROUNDWATER

- 5–10 ug/l
- 10–100 ug/l
- 100–1000 ug/l
- 1000–1500 ug/l

ACTUAL TRICHLOROETHENE (TCE) CONCENTRATIONS IN GROUNDWATER (2002)

Extraction well

Slurry wall and extraction trench

0 1000 2000

Scale in Feet

HILL AIR FORCE BASE OPERABLE UNIT 12

OGDEN ALC

MODEL PREDICTED TCE CONCENTRATIONS FOR ALTERNATIVE 2 SLURRY WALL AND EXTRACTION TRENCH

FIGURE A3–2

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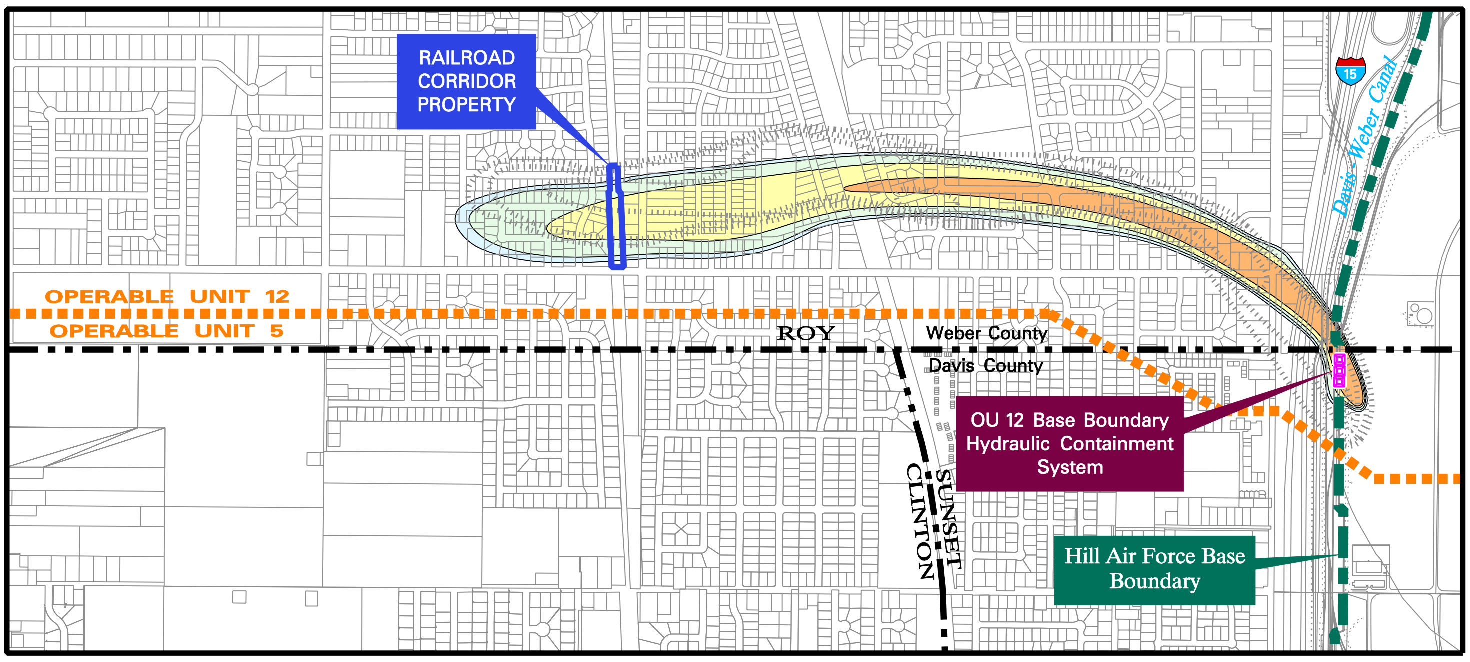
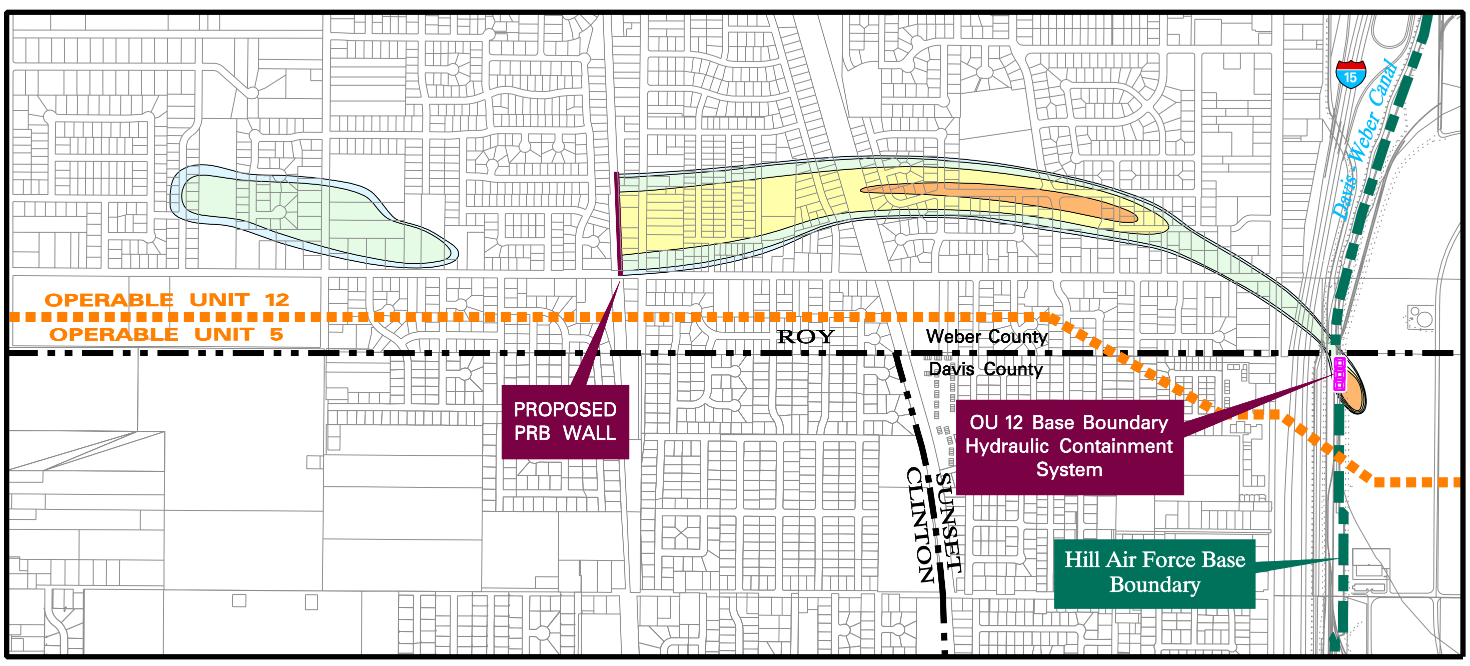
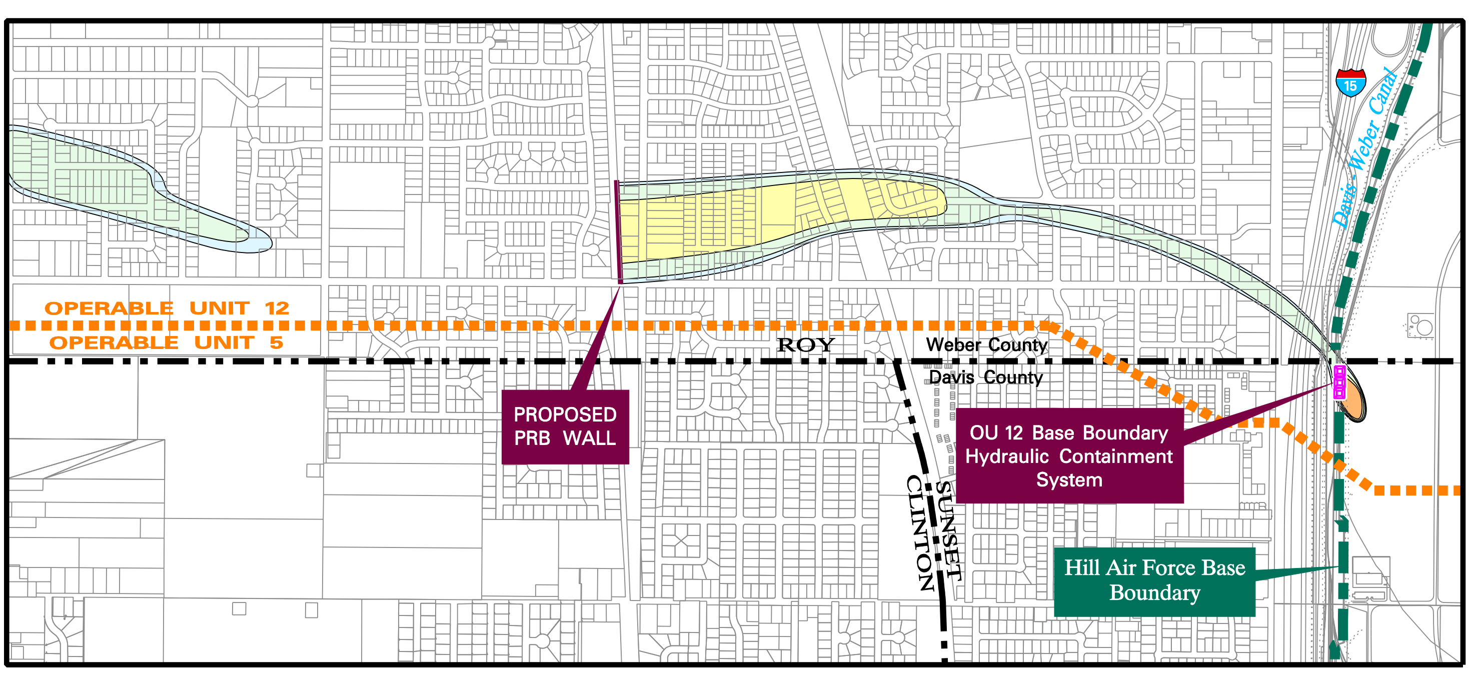


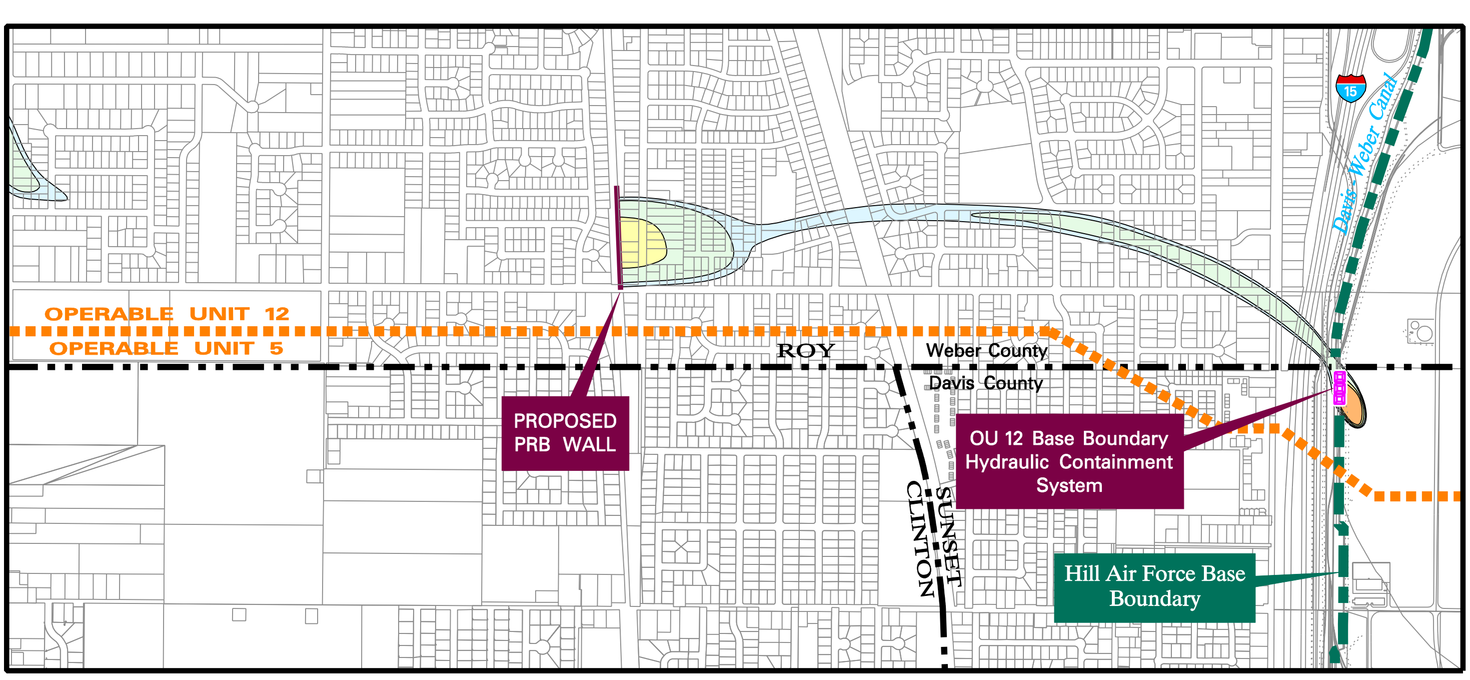
TCE CONCENTRATIONS FOR INITIAL CONDITIONS



SIMULATED TCE CONCENTRATIONS AFTER 10 YEARS



SIMULATED TCE CONCENTRATIONS AFTER 20 YEARS



SIMULATED TCE CONCENTRATIONS AFTER 30 YEARS

EXPLANATION

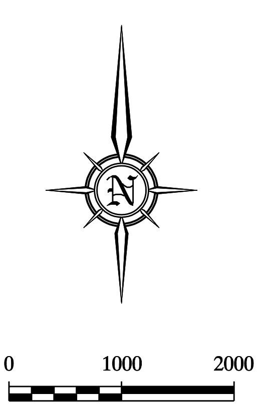
MODEL PREDICTED TRICHLOROETHENE (TCE) CONCENTRATIONS IN GROUNDWATER

- 5–10 ug/l
- 10–100 ug/l
- 100–1000 ug/l
- 1000–1500 ug/l

ACTUAL TRICHLOROETHENE (TCE) CONCENTRATIONS IN GROUNDWATER (2002)

Extraction well

Permeable Reactive Barrier (PRB) wall



HILL AIR FORCE BASE OPERABLE UNIT 12

MODEL PREDICTED TCE CONCENTRATIONS FOR ALTERNATIVE 3 PERMEABLE REACTIVE BARRIER (PRB) WALL

FIGURE A3–3

APPENDIX B

ARAR TABLES

TABLE B-1

IDENTIFICATION OF FEDERAL CHEMICAL-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	**Citation**	**Description**	**Applicable/ Relevant and Appropriate**	**Alternatives Affected**	**Compliance Comment**
Solid Waste Disposal Act	42 USC Sec. 6901-6987				
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 270, 271, 124 and land disposal restrictions (LDRs) under 40 CFR 268.	Yes/---	1,2,3	**Yes. All affected alternatives will comply.** May apply to some remedy construction waste including monitoring well installation waste. The corrective action management unit (CAMU) regulations under 40 CFR 264 apply. CAMU-eligible waste include all solid and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris, that are managed for implementing cleanup.
Safe Drinking Water Act	42 USC Sec. 300g				
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems (MCL).	---/Yes	1,2,3	**Yes. All alternatives will eventually comply with this ARAR downgradient.** Groundwater contamination downgradient of the system location is expected to decrease with the containment of the plume between the 5 µg/l isoconcentration contour of the plume. Naturally occuring arsenic may be mobilized in a small zone downgradient of the Alternative 3 permeable reactive barrier (PRB) wall as a result of pH conditions generated by operation of the PRB wall. As treated groundwater renters the aquifer the pH conditions will re-equilibrate to normal values (within 5 to 10 feet downgradient) and the arsenic will reprecipitate.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes welfare-based standards for public water systems (secondary MCL).	No/No		The SMCLs are guidance only and are not enforceable. As a result they are to be considered (TBC) and will be considered for inorganics.

TABLE B-1

IDENTIFICATION OF FEDERAL CHEMICAL-SPECIFIC ARARs
(Page 2 of 3)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Clean Water Act	33 USC Sec. 1251-1376				
Water Quality Criteria	40 CFR Part 131	Sets criteria for developing water quality standards based on toxicity to aquatic organisms and human health.	No/Yes	1,2,3	**See discussion for 40 CFR Part 141.** Relevant and appropriate because the shallow aquifer is a potential drinking water source.
National Pretreatment Standards	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in POTW treatment works or which may contaminate sewage sludge.	Yes/---	2	**Yes. Alternatives that include discharges to a POTW will comply.** Potential chemical and action-specific ARAR for discharge to a POTW.

TABLE B-1

IDENTIFICATION OF FEDERAL CHEMICAL-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Clean Air Act	42 USC Sec. 7401-7642				
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead).	---/Yes	1	Relevant and appropriate to Alternative 1 which has air emissions.
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61 Subpart A	Sets emission standards for designated hazardous pollutants.	---/Yes	1	Relevant and appropriate to Alternative 1 which has air emissions.

TABLE B-2

IDENTIFICATION OF FEDERAL ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 61	Designates substances as hazardous air pollutants and establishes emission standards.	No/Yes	1	**Yes.** Relevant and appropriate to emissions from groundwater treatment facilities such as those generated by the aeration curtain.
Solid Waste Disposal Act	42 USC Sec. 6901-6987				
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment.	---/Yes	1,2,3	**Yes. All alternatives will comply.** Relevant to alternatives where soils excavated from below the water table will remain on site. Soils from construction of trenches will remain on site and will be covered by clean topsoil. CAMU regulations apply.
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines those solid wastes which are subject to regulation as hazardous wastes and applicability of land disposal restrictions.	Yes/---	1,2,3	**Yes. All alternatives will comply**. May apply to some remedy construction waste. The CAMU regulations under 40 CFR 264 apply. CAMU-eligible waste include all solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that are managed for implementing cleanup.
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Establishes standards for generators of hazardous waste.	Yes/--	1,2,3	**Yes. All alternatives will comply.**

TABLE B-2

IDENTIFICATION OF FEDERAL ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Solid Waste Disposal Act (continued)					
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 264	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Yes/Yes		See discussion of specific subparts.
• Preparedness and Prevention	Subpart C	Specifies requirements for communications, alarm systems and coordination with local authorities.	Yes/---	1,2	**Yes.** Applicable to onsite waste management of generated hazardous waste in the groundwater treatment system, if any. Addressed by provisions in the *Hill AFB Spill Prevention, Control and Counter Measures Plan (June 2001)*.
• Contingency Plan and Emergency Procedures	Subpart D	Requires development of a contingency plan and designation of an emergency coordinator.	Yes/---	1,2	**Yes.** Applicable to onsite waste management of generated hazardous waste in the groundwater treatment system, if any. Addressed by provisions in the *Hill AFB Spill Prevention, Control and Counter Measures Plan (June 2001)*.
• Manifest System, Record Keeping, and Reporting	Subpart E	264.73 Operating record	---/Yes	1,2	**Yes.** Relevant and appropriate to onsite waste management.

TABLE B-2

IDENTIFICATION OF FEDERAL ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Solid Waste Disposal Act (continued) • Releases from Solid Waste Management Units	Subpart F		---/Yes	1,2,3	**Yes.** The requirements for detection of releases from Solid Waste Management Units of this potential ARAR relative to source areas are addressed through monitoring of groundwater quality down gradient of the system.
• Closure and Post-Closure	Subpart G 40 CFR 264.111 Closure Standards 40 CFR 264.112 Closure Plan 40 CFR 264.114 Disposal or Decontamination 40CFR 264.116 Survey Plat 40 CFR 264.117 Post Closure care and use 40 CFR 264.118 Post Closure Plan 40 CFR 264.119 Post closure notices		No/Yes	1,2,3	Relevant and appropriate for alternatives where some contamination may remain in groundwater or on site. Closure plan requirements are met by the decision documentation required for the final Record of Decision (ROD) and the post-ROD design, operation and maintenance, and performance standard verification plans for the final remedy for the site, when implemented.

TABLE B-2

IDENTIFICATION OF FEDERAL ACTION-SPECIFIC ARARs
(Page 4 of 5)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Solid Waste Disposal Act (continued)					
• Use and Management of Containers	Subpart I	Requirements for storage of hazardous waste in containers.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Applicable to onsite waste management of generated hazardous waste, if any.
• Tanks	Subpart J	Requirements for storage of hazardous waste in tanks.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Applicable to onsite waste management of generated hazardous waste.
• Corrective Action for Solid Waste Management Units	Subpart S	Establishes the corrective action program for cleaning up solid waste management units. This part of the regulation also includes the definition of a CAMU to facilitate waste management associated with cleanup activities. Hazardous waste moved within a CAMU is not subject to LDRs.	Yes/---	1,2,3	Applicable to onsite soil treatment units. The CAMU would be designated to include the source area and the area of groundwater contamination in excess of MCLs. Soils and wastes excavated as part of remedy implementation would remain on site.
Land Disposal Restrictions	40 CFR Part 268	Identifies hazardous wastes that are restricted from land disposal.	Yes/---	1,2,3	**Yes. All affected alternatives will comply.** Applicable to storage and treatment of generated RCRA hazardous waste or soils containing RCRA-listed wastes disposed off-site. May apply to some remedy construction waste including monitoring well installation waste outside the CAMU. Because all excavated soils will be placed within the CAMU for all alternatives, LDRs do not have to be met.

TABLE B-2

IDENTIFICATION OF FEDERAL ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Clean Water Act	33 USC Sec. 1251-1376				
National Pretreatment	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly owned treatment works or which may contaminate sewage sludge.	Yes/---	2	**Yes. The alternative will comply.** Discharge to POTW is part of the Alternative 2 Slurry Wall and Extraction Trench..

TABLE B-3

IDENTIFICATION OF FEDERAL LOCATION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Endangered Species Act	16 USC Sec. 1531-1543 40 CFR 6-302(h) 50 CFR Part 200 50 CFR Part 402	Requires that Federal agencies insure that any action authorized, funded, or carried by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	Yes/---	1,2,3	The proposed construction site is in a highly developed area and therefore will not impact this ARAR.
National Historic Preservation Act	16 USC Sec. 470s 36 CFR 800	Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on historic properties.	Yes/---	1,2,3	Alternatives will not impact any historic places.
Executive Order on Protection and Enhancement of the Cultural Environment	Exec. Order #11,593	Establishes consultation procedures and responsibilities of Federal agencies for historic preservation.	No/No		Substantive requirements can be met through compliance with 36 CFR Part 800.

TABLE B-4

IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Utah Public Drinking Water Regulations	UAC R309-103-2	Establishes maximum contaminant levels for inorganic and organic chemicals.	No/Yes	1,2,3	Requirements are relevant and appropriate. Some MCLs established for contaminants not Federally regulated (e.g., total dissolved solids). **All alternatives will eventually comply with this ARAR downgradient.** All alternatives will comply with this ARAR by capturing and treating groundwater contaminated at concentrations that exceed the TCE MCL as currently defined. Groundwater contamination downgradient of the system location is expected to decrease with the containment of the plume between the 5 μg/l isoconcentration contour of the plume. Naturally occuring arsenic may be mobilized in a small zone downgradient of the Alternative 3 PRB wall as a result of pH conditions generated by operation of the PRB wall. As treated groundwater re-enters the aquifer and pH conditions re-equilibrate to normal values (within 5 to 10 feet downgradient) the arsenic will reprecipitate.
Utah Public Drinking Water Regulations- Secondary Standards	UAC R309-103-3	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels).	No/Yes	1,3	May be relevant and appropriate for inorganics not addressed by R309-1-3-2 (i.e. iron, manganese). Not relevant for discharges to the POTW under Alternative 2. **See discussion for R309-103-2.**

TABLE B-4

IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Corrective Action Clean-up Standards Policy - UST and CERCLA Sites.	UAC R311-211	Lists general criteria to be considered in establishing clean-up standards including compliance with MCLs in Safe Drinking Water Act and Clean Air Act. Requires action to be taken to be protective. Requires source removal or control of source and prevention of further degradation. In the case of contamination above the MCL, if, after evaluation of all alternatives, it is determined that applicable minimum standards cannot reasonably be achieved, clean-up levels above these standards may be established on a case-by-case basis utilizing R311-211-3 and R311-211-4.	Yes/---	1,2,3	**The alternatives proposed for this EE/CA do not, and are not intended to comply with this ARAR.** Known sources of continuing groundwater degradation will be controlled when the final remedial action is selected. However, continued operation of the OU12 Base Boundary Hydraulic Containment System achieves compliance with this ARAR in the interim. **Prevent Further Degradation (R311-211-4).** Contaminant concentrations downgradient of the containment trench are expected to decrease with the containment of the plume with contaminant concentrations greater than 5 μg/l. **Cleanup Standards (R311-211-5).** The need for implementing this ARAR would be evaluated, at a minimum, during the statutory 5-year reviews after selection of the final remedy.

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Ground-Water protection standards for TSDFs	UAC R315-8-6	Ground-water protection standards for owners and operators of hazardous waste TSDFs.	No/No	1,2,3	**Yes. All affected alternatives will comply.** The requirements for detection of releases from Solid Waste Management Units of this potential ARAR relative to source areas are addressed through monitoring of groundwater quality downgradient of the system. State counterpart of 40 CFR 264 Subpart F.
Clean-up and Risk-Based Closure Standards-RCRA, UST, and CERCLA sites	UAC R315-101	R315-101 establishes requirements to support risk-based cleanup and closure standards at sites for which remediation or removal of hazardous constituents to background levels will not be achieved. The procedures in this rule also provide for continued management of sites for which minimal risk-based standards cannot be met. Requires removal or control of the source and non-degradation beyond existing contaminant levels. Requires reporting to verify compliance.	Yes/---	1,2,3	**The proposed action will comply under the provisions of R315-101-1(b) (4).** The proposed action will comply because institutional controls can be expanded to address future potential risk scenarios resulting from plume migration or use of shallow groundwater until a final remedy is selected. R315-101-2 Stabilization will be achieved by controlling the continued downgradient movement of the plume. Non-degradation under R315-101-3 will be achieved to the extent possible given the location selected for the proposed action if future monitoring indicates that contaminant concentrations are decreasing downgradient of the containment system.

TABLE B-4

IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Clean-up and Risk-Based Closure Standards-RCRA, UST, and CERCLA sites (continued)	UAC R315-2	Criteria for the Identification and Listing of Hazardous Waste	Yes/---	1,2,3	**Yes. All alternatives will comply**. Determines potential waste classification and applicability of land disposal restrictions and other solid and hazardous waste rules. State counterpart of 40 CFR 261. The CAMU regulations under 40 CFR 264 apply. CAMU-eligible waste include all solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that are managed for implementing cleanup.
Standards of Quality for Waters of the State	UAC R317-2	Standards for Quality for Waters of the State.	No/No		These rules are specific to Utah surface waters, though they are derived in part by using Federal criteria. See particularly the anti-degradation policy in UAC R317-2-3. None of the alternatives discharge directly to waters of the state.
Ground-Water Quality Protection.	UAC R317-6	Ground-Water Quality Protection.	No/No		R317-6-6.15 states that this regulation is TBC under any state or federal Superfund action but the protective levels are not to be considered as applicable, relevant, or appropriate for such actions.
Utah Air Conservation Regulations	UAC R307-107-1	R307-107 applies to all regulated pollutants including those for which there are National Ambient Air Quality Standards. Except as otherwise provided in R307-107, emissions resulting from an unavoidable breakdown will not be deemed a violation of these regulations. .	---/Yes	1	Relevant and appropriate to Alternative 1 which has air emissions.

TABLE B-4

IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Utah Air Conservation Regulations (continued)	UAC R307-205-3	Construction and Demolition Activities. Fugitive Dust Control.	Yes/---	1,2,3	**Yes. All affected alternatives will comply.** Applicable to those alternatives that require clearing or levelling of land greater than one-quarter acre in size, earthmoving, excavation, or movement of trucks or construction equipment over cleared land greater than one-quarter acre in size or access haul roads.
	UAC R307-210	The standards of performance for new stationary sources in 40 CFR 60 (1998), as amended by 63 FR 49442, 64 FR 7457, 64 FR 9257, and 64 FR 10105 are incorporated by reference.	Yes/---	1	Relevant and appropriate to Alternative 1 which has air emissions.
National Emission Standards for Hazardous Air Pollutants (NESHAP)	UAC R307-214	NESHAP are incorporated by reference (see 40 CFR 61 Subpart A).	No/Yes	1	Relevant and appropriate to emissions from groundwater treatment facilities such as those generated by the aeration curtain.
Salt Lake and Utah Counties, Ogden City and Any Nonattainment Area for PM10	UAC R307-309-4	Fugitive Emissions and Fugitive Dust.	Yes/---	1,2,3	**Yes. All affected alternatives will comply.** Requires the submission of a plan that shall address fugitive dust control strategies. Substantive requirements only are applicable.

TABLE B-4

IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Davis and Salt Lake Counties and Ozone Nonattainment Areas: Ozone Provisions	UAC R307-325-1	No person may permit or cause volatile organic compounds (VOCs) to be spilled, discarded, stored in open containers, or handled in any other manner, which would result in evaporation in excess of that which would result from the application of reasonably available control technology (RACT) (as defined in 40 CFR 51.100(o)).	Yes/---	1,2,3	**Yes. All affected alternatives will comply.**
Prevention of Significant Deterioration (PSD) of Air Quality.	UAC R307-405-6(1)	Provides exemptions from R307-405-6 (2) if the new source is not defined as a major source.	Yes/---	1	Alternative 1 would not be a major source and would be covered by the requirements of R307-413-8.
	UAC R307-410-4	**Documentation of Ambient Air Impacts for Hazardous Air Pollutants.**	Yes/---	1	**Yes. All affected alternatives will comply.** Defines limits for *De minimus* exemption status under R307-413-8. Applicable to remedial alternatives that may discharge contaminants to air.

TABLE B-4

IDENTIFICATION OF STATE CHEMICAL-SPECIFIC ARARS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Permits:Exemptions and Special Provisions	UAC R307-413-8	*De minimus* emissions from Air Strippers and Soil Venting Projects. Approval is not required under R307-401 if total emissions of VOCs are less than the 5 tons per year limit defined in R307-413-2(1)(c) and hazardous air pollutants are below the levels listed in R307-410-4(1)(d).	Yes/---	1	Applicable to Alternative 1 which will discharge contaminants to air. Sampling and calculations verifying compliance must be submitted. Sampling frequency for compliance is defined.

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Corrective Action Clean-up Standards Policy - UST and CERCLA Sites.	UAC R311-211	Lists general criteria to be considered in establishing clean-up standards including compliance with MCLs in Safe Drinking Water Act and Clean Air Act. Requires action to be taken to be protective. Requires source removal or control of source and prevention of further degradation. In the case of contamination above the MCL, if, after evaluation of all alternatives, it is determined that applicable minimum standards cannot reasonably be achieved, clean-up levels above these standards may be established on a case-by-case basis utilizing R311-211-3 and R311-211- 4.	Yes/---	1,2,3	**Source Control (R311-211-2). The alternatives proposed for this EE/CA do not, and are not intended to comply with this ARAR.** Known sources of continuing groundwater degradation will be controlled when the final remedial action is selected. However, continued operation of the OU12 Base Boundary Hydraulic Containment system achieves compliance with this ARAR in the interim. **Prevent Further Degradation (R311-211-4).** Contaminant concentrations downgradient of the containment trench are expected to decrease with the containment of the plume with contaminant concentrations greater than 5 µg/l. **Cleanup Standards (R311-211-5).** The need for implementing this ARAR would be evaluated, at a minimum, during the statutory 5-year reviews after selection of the final remedy.
General Requirements - Identification and Listing of Hazardous Waste	UAC R315-2	Defines those solid wastes which are subject to regulation as hazardous wastes.	Yes/---	1,2,3	**Yes. All alternatives will comply**. Determines potential waste classification and applicability of land disposal restrictions and other solid and hazardous waste rules. State counterpart of 40 CFR 261. The CAMU regulations under 40 CFR 264 apply. CAMU-eligible waste include all solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that are managed for implementing cleanup.

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Hazardous Waste Manifest Requirements	UAC R315-4	Establishes standards for manifesting hazardous waste.	Yes/---	1,2,3	**Yes. All alternatives will comply**. Applicable to alternatives involving landfilling of hazardous soil and debris off site. Not applicable to landfilling of non-hazardous materials. The CAMU regulations under 40 CFR 264 apply. CAMU-eligible waste include all solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that are managed for implementing cleanup. State counterpart of 40 CFR 261.
Hazardous Waste Generator Requirements	UAC R315-5	Establishes standards for generators of hazardous waste.	Yes/---	1,2,3	**Yes. All alternatives will comply**. May apply to some remedy construction waste including monitoring well installation waste. The CAMU regulations under 40 CFR 264 apply. CAMU-eligible waste include all solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that are managed for implementing cleanup. State counterpart of 40 CFR 262.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	UAC R315-8	Establishes minimum standards which define the acceptable management of hazardous waste for owners and operators of TSDFs.			See discussion for specific subparts below.
Preparedness and Prevention	UAC R315-8-3	Describes communications, alarm systems and coordination with local authorities.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Applicable to onsite waste management of generated hazardous waste in the groundwater treatment system, if any. Addressed by provisions in the *Hill AFB Spill Prevention, Control and Counter Measures Plan (June 2001).*

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs
(Page 3 of 8)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Contingency Plan and Emergency Procedures	UAC R315-8-4	Requires development of a contingency plan and designation of an emergency coordinator.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Addressed by provisions in the *Hill AFB Spill Prevention, Control and Counter Measures Plan (June 2001).*
Manifest System, Record-Keeping, and Reporting	UAC R315-8-5	Requires manifesting, record keeping and regular reporting.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Applicable to onsite waste management of generated hazardous waste, if any. State counterpart of 40 CFR 264 Subpart E.
Groundwater Protection	UAC R315-8-6	Describes groundwater monitoring requirements for TSDFs.	---/Yes	1,2,3	**Yes. All affected alternatives will comply.** The requirements for detection of releases from Solid Waste Management Units of this potential ARAR relative to source areas are addressed through monitoring of groundwater quality downgradient of the system. State counterpart of 40 CFR 264 Subpart F.
Closure and Post-Closure	UAC R315-8-7	Establishes closure and post-closure performance standards and plan requirements for TSDFs.	---/Yes	1,2,3	**Yes. All affected alternatives will comply.** Relevant and appropriate for alternatives where some contamination may remain in on site or in groundwater. Relevant and appropriate for alternatives where some contamination may remain in groundwater or on site. Closure plan requirements will be met by the decision documentation required for the final Record of Decision (ROD) and the Post ROD design, operation and maintenance, and performance standard verification plans for the final remedy for the site, when implemented. State counterpart of 40 CFR 264 Subpart G.
Use and Management of Containers	UAC R315-8-9	Requires specific procedures for the temporary storage of hazardous wastes in containers.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Applicable to onsite waste management of generated hazardous waste. State counterpart of 40 CFR 264 Subpart I.

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs
(Page 4 of 8)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Tanks	UAC R315-8-10	Requires specific procedures for the use of tanks for the treatment or temporary storage of hazardous wastes in tanks.	Yes/---	1,2	**Yes. All affected alternatives will comply.** Applicable to onsite waste management of generated hazardous waste. State counterpart of 40 CFR 264 Subpart I.
Corrective Action for Solid Waste Management Units	UAC R315-8-21	Establishes requirements for designation of a CAMU and defines management practices.	Yes/---	1,2,3	Applicable to onsite soil treatment units. The CAMU would be designated to include the source area and the area of groundwater contamination in excess of MCLs. Soils and wastes excavated as part of remedy implementation would remain on site. State counterpart of 40 CFR 264 Subpart S.
Land Disposal Restrictions	UAC R315-13	Identifies hazardous wastes that are restricted from land disposal.	Yes/---	1,2,3	**Yes. All affected alternatives will comply.** Applicable to storage and treatment of generated RCRA hazardous waste or soils containing RCRA-listed wastes disposed off-site. May apply to some remedy construction waste including monitoring well installation waste outside the CAMU. Because all excavated soils will be placed within the CAMU for all alternatives, LDRs do not have to be met. State counterpart of 40 CFR 268.

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs
(Page 5 of 8)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Clean-up and Risk-Based Closure Standards	UAC R315-101	R315-101 establishes information requirements to support risk-based cleanup and closure standards at sites for which remediation or removal of hazardous constituents to background levels will not be achieved. Requires continued management of sites for which minimal risk-based standards cannot be met. Requires removal or control of the source and non-degradation beyond existing contamination levels. Requires reporting to verify compliance.	Yes/---	1,2,3	**All alternatives will comply under the provisions of R315-101-1(b) (4).** The proposed action will comply because institutional controls can be expanded to address future potential risk scenarios resulting from plume migration or use of shallow groundwater until a final remedy is selected. R315-101-2 Stabilization will be achieved by controlling the continued downgradient movement of the plume. Non-degradation under R315-101-3 will be achieved for the proposed action if future monitoring indicates that contaminant concentrations are decreasing downgradient of the containment system.
Construction and performance requirements for POTWs	UAC R317-3	Sewers and wastewater treatment works.	No/Yes	2	Construction and performance requirements for remedial works will be relevant and appropriate to Alternative 2 which discharges to the POTW.
Ground-Water Quality Protection	UAC R317-6	Ground-Water Quality Protection.	No/No		R317-6-6.15 states that this regulation is to-be-considered under any state or federal Superfund action but the protective levels are not to be considered as applicable, relevant, or appropriate for such actions.
Utah Pollution Discharge Elimination System (UPDES)	UAC R317-8-7	Criteria and standards for the imposition of technology-based treatment requirements and represents the minimum level of control that must be imposed in a UPDES permit.	Yes/---	2	**Yes.** Alternative 2 will comply with substantive requirements.

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	**Citation**	**Description**	**Applicable/ Relevant and Appropriate**	**Alternatives Affected (Bold)**	**Compliance Comment**
Pretreatment	UAC R317-8-8	Sets standards for discharge to a POTW.	Yes/---	2	**Yes.** Alternative 2 will comply with substantive requirements.
Air Quality	UAC R307-101-2	Defines prohibited levels of air pollution	Yes/---	1	**Yes.** Discharge levels for Alternative 1 will comply.
	UAC R307-102-1	Emission of air contaminants in sufficient quantities to cause air pollution as defined in R307-101-2 is prohibited.	Yes/---	1	**Yes.** Alternative 1 will comply with the substantive requirements of this ARAR. Emission levels are *de minimus.*
	UAC R307-107	Except as otherwise provided in R307-107, emissions resulting from an unavoidable breakdown will not be deemed a violation of these regulations.	Yes/---	1	Applicable to Alternative 1.
Construction and Demolition Activities	UAC R307-205-3	Construction and Demolition Activities. Fugitive Dust Control.	Yes/---	1,2,3	**Yes. All alternatives will comply.** Applicable to those alternatives that require clearing or levelling of land greater than one-quarter acre in size, earthmoving, excavation, or movement of trucks or construction equipment over cleared land greater than one-quarter acre in size or access haul roads.
Standards for Stationary Air Sources	UAC R307-210	The standards of performance for new stationary sources in 40 CFR 60 (1998), as amended by 63 FR 49442, 64 FR 7457, 64 FR 9257, and 64 FR 10105 are incorporated by reference.	Yes/---	1	**Yes.** Alternative 1 will comply with substantive requirements.

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
National Emission Standards for Hazardous Air Pollutants (NESHAP)	UAC R307-214	National Emission Standards for Hazardous Air Pollutants (NESHAP) are incorporated by reference.	No/Yes	1	Relevant and appropriate to emissions from groundwater treatment facilities such as those generated by the aeration curtain.
Salt Lake and Utah Counties, Ogden City and Any Nonattainment Area for PM10	UAC R307-309-4	Fugitive Emissions and Fugitive Dust.	Yes/---	1,2,3	**Yes. All alternatives will comply.** Requires the submission of a plan that shall address fugitive dust control strategies. Substantive requirements only are applicable.
Davis and Salt Lake Counties and Ozone Nonattainment Areas: Ozone Provisions.	UAC R307-325-1	No person may permit or cause volatile organic compounds (VOCs) to be spilled, discarded, stored in open containers, or handled in any other manner, which would result in evaporation in excess of that which would result from the application of reasonably available control technology (RACT) (as defined in 40 CFR 51.100(o)).	Yes/---	1,2,3	**Yes. All alternatives will comply.**
Prevention of Significant Deterioration (PSD) of Air Quality.	UAC R307-405-6(1)	Provides exemptions from R307-405-6 (2) if the new source is not defined as a major source.	Yes/---	1	Alternative 1 would not be a major source and would be covered by the requirements of R307-413-8.
	UAC R307-410-4	Documentation of Ambient Air Impacts for Hazardous Air Pollutants.	Yes/---	1	**Yes. All affected alternatives will comply.** Defines limits for *De minimus* exemption status under R307-413-8. Applicable to Alternative 1.

TABLE B-5

IDENTIFICATION OF STATE ACTION-SPECIFIC ARARs

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected (Bold)	Compliance Comment
Permits: Exemptions and Special Provisions	UAC R307-413-8	*De minimus* emissions from Air Strippers and Soil Venting Projects. Approval is not required under R307-401 if total emissions of VOCs are less than the 5 tons per year limit defined in R307-413-2(1)(c) and hazardous air pollutants are below the levels listed in R307-410-4(1)(d).	Yes/---	1	**Yes.** Applicable to Alternative 1 Air Sampling and calculations verifying compliance must be submitted. Sampling frequency for compliance is defined.
Well Drilling Standards	UAC R655-4	Standards for drilling and abandonment of wells.	---/Yes	1,2,3	**Yes. All alternatives will comply.** Includes such requirements as performance standards for casing joints, requirements for abandoning a well, etc. Relevant to monitoring well construction or replacement.

APPENDIX C

COST ESTIMATES

TABLE C-1

ALTERNATIVE 1: AERATION CURTAIN
EE/CA FOR OU 12
HILL AIR FORCE BASE, UTAH

Item No.	Item	Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
1	**DIRECT CAPITAL COSTS**						
Aeration Curtain - 660 ft long, 3 ft wide and 30 ft deep							
	Biopolymer Slurry Trenching Contractor Mob/Demob		1	LS	$50,000	$50,000	Envirocon estimate; Includes excavation equipment and slurry holding tanks
	Construction of trench, installation of sparge pipes and backfill with graded gravel pack (Squeegy)		1	LS	$250,000	$250,000	Envirocon estimate; Includes cost of biopolymer and enzyme breaker; tanks to hold the slurry until disposal; Includes cost of trench support berm construction, installation of sparge piping and backfill with graded gravel.
	Sparge piping Cost		16,800	LF	$3.16	$53,088	ECHOS Environmental Restoration estimate # 33 26 0512 for 4" HDPE; Installation provided by the trenching subcontractor
	Cost of Squeegy for backfill to 1 ft bgs		2,892	Tons	$10.75	$31,092	660ftx29ftx3ft; 1.36 tons/CY; quote from Geneva Rock; includes delivery to site
	SVE piping		7,500	LF	$13.55	$101,625	ECHOS Environmental Restoration estimate # 33 26 0404 for 4" PVC
	Impermeable membrane cover of the SVE lines		670	SY	$7	$4,690	670 ftx9 ft; 30 mil thick HDPE membrane; inclusive of labor; Engineering estimate
	Backfill with top soil from 1 ft bgs to 2 ft above ground surface, no compaction		220	CY	$1.52	$334	660ftx3ftx3ft; 2003 Means 02315-505-0010
	Compact the top soil		220	CY	$1.34	$295	660ftx3ftx3ft; 2003 Means 02315-300-6220
	Haul dewatered curtain trench spoils to SMS at Hill AFB (only if fails screening criteria)		1980	CY	$20	$39,600	660ftx27ftx3ft; includes only soils that are below the water table; includes loading, unloading, and spreading costs at the SMS and later pickup and dump at Hill AFB landfill
	Conditioning of slurry to be acceptable for discharge to POTW		1	LS	$20,000	$20,000	Engineering estimate
	Disposal of broken-down slurry to POTW		800	1000 Gallons	$0.60	$480	Fee currently charged by North Davis County Sanitation District
	Temporary Wastewater Discharge Permit		1	LS	$2,000	$2,000	Engineering estimate
	Haul dried sediment from the biopolymer slurry tanks to SMS Hill AFB		500	CY	$20	$10,000	Sediment volume estimate from Envirocon; includes loading, unloading, and spreading costs at the SMS and later pickup and dump at Hill AFB landfill
	Trenching, backfill and compaction of piping header trench leading from the Curtain to the building		167	CY	$9.57	$1,595	250ftx6ftx3ft; 2003 Means 02315-900-0010, 02315-900-3020, 02315-300-6220
Aeration Equipment							
	Air Sparge Blowers (3 duty + 1 spare)		1	LS	$123,600	$123,600	Industrial Products estimate for Roots blowers; Each rated 40 HP at 220 cfm @ 18 psi. Includes VFD and silencer for each blower. Includes the cost of a heat exchanger.
	SVE Blowers (1 duty + 1 spare)		1	LS	$36,900	$36,900	Industrial Products estimate for Roots blowers; Each rated 9 HP at 800 cfm @ 6" Hg. Includes VFD, silencer for each blower.
	Air cooled heat exchanger		1	each	$0	$0	Included in the sparge blower costs
	Pressure gauges on the sparge pipes		24	each	$200	$4,800	22 gauges + 2 spares
	Vacuum gauges on the suction pipes		13	each	$200	$2,600	11 gauges + 2 spares
	Aeration Equipment Installation Cost		50%	Equipment Costs	$167,900	$83,950	Engineering estimate
Air Permit							
	Obtain permit for discharging of off-gases from the aeration curtain to atmosphere without treatment		1	LS	$5,000	$5,000	Engineering estimate

TABLE C-1

ALTERNATIVE 1: AERATION CURTAIN
EE/CA FOR OU 12
HILL AIR FORCE BASE, UTAH

Item No.	Item	Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
	Monitoring Well Installation						
		12 Monitoring wells (2.5"dia, 30 ft deep)	12	Monitoring Well	$4,800	$57,600	Lump sum price includes PVC riser pipe, PVC screen, well development, vault box installation and disposal of IDW
	Utility Disruption						
		Water, Sewer, Gas, Power, Telephone, Cable, etc.	2	Households	$0	$0	Not Applicable
		Fiber Optic Cable	1	LS	$25,000	$25,000	Relocation costs for the fiber optic cable line running parallel to the proposed system location; Engineering estimate includes 3Com charge of $18,000
	Site Restoration		1	LS	$3,000	$3,000	Lawn replacement estimate
	Characterization Sampling and Analysis						
		Baseline sampling of groundwater around the Curtain for TCE and water quality parameters	1	LS	$12,582	$12,582	12 wells sampled for VOCs and water quality parameters; $7,582 for sampling, analysis, data validation; $5,000 for ERPIMS deliverable.
	Process Building						
		Treatment Building - residential appearance (inclusive of Civil, Mechanical and Electrical Components)	1	LS	$373,000	$373,000	Based on OU 12 Base Boundary Containment System/ OU 5 Phase III location
		System Prove Out/ Optimization	192	hrs	$70	$13,440	Engineering estimate; one operator at full-time for 4 weeks @ $70/hr and 20% labor oversight
	Scope Contingency						
		Contingency Costs	20%	Capital Costs	$1,306,271	$261,254	See Note 1
		Subtotal Capital Costs				**$1,567,525**	
		Project Management (Hill AFB)	6%	Capital Costs	$1,567,525	$94,052	See Note 2.
		Remedial Design	12%	Capital Costs	$1,567,525	$188,103	See Note 2.
		Construction Management/Oversight	6%	Capital Costs	$1,567,525	$94,052	See Note 2.
		Site Security	1%	Capital Costs	$1,567,525	$15,675	See Note 3
		Traffic Management Plan	1%	Capital Costs	$1,567,525	$15,675	See Note 3
		Subcontractor Installation Costs				**$407,557**	
		Remedial Action Contractor (RAC) Administrative Costs	10%	Capital Costs	$1,567,525	$156,753	Engineering estimate based on previous Hill AFB projects
		Profit	8%	Capital & Installation Costs	$1,975,082	$158,007	Engineering estimate based on previous Hill AFB projects
		Subcontractor Mark-up & Profit				**$314,759**	
		TOTAL DIRECT COSTS				**$2,289,841**	Inclusive of subcontractor mark-up (10%) and profit (8%).
2	**ANNUAL COSTS**						
	Annual Monitoring Costs of Performance Monitoring Wells						
		Annual monitoring of 12 wells for VOCs and field parameters	1	/Yr	$12,582	$12,582	12 wells sampled for VOCs and water quality parameters; $7,582 for sampling, analysis, data validation; $5,000 for ERPIMS deliverable.
		Analytical Data Report	1	/Yr	$20,000	$20,000	From OU 5
		Well/Vault Replacement Costs	1	LS	$5,000	$5,000	Assumed average annual expenditure for monitoring well and/or vault replacement at the rate of one well per year.
	Annual O&M of Containment System						
		Electrical Requirements	980,244	kW-hr	$0.07	$68,700	Approximately 150 HP around the year
		Subcontractor O&M Charges (minus electrical costs)	1	/Yr	$74,300	$74,300	Hill AFB estimates $143,000 for all O&M costs, including electrical charges.

TABLE C-1

ALTERNATIVE 1: AERATION CURTAIN
EE/CA FOR OU 12
HILL AIR FORCE BASE, UTAH

Item No.	Item Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
	Quarterly monitoring of off-gases	4	/Yr	$1,500	$6,000	Air sampling for VOCs and flow; Inclusive of sampling labor
	TSOR for Containment System	1	/Yr	$30,000	$30,000	TSOR - treatment system operation report
	Lease Agreement for the Railroad Corridor Site	1	LS	$0	$0	Not Applicable
	Lease City-Owned Site for locating the treatment building	1	Year	$6,000	$6,000	Engineering estimate
			SUBTOTAL ANNUAL COSTS		**$222,582**	
	30-YEAR PRESENT WORTH OF ANNUAL COSTS (i=4%;n=30,P/A=17.2920)				**$3,848,888**	
3	**SUMMARY REPORT (Every 5 Years)**	1	/5 Yrs	$35,000		
	30-YEAR PRESENT WORTH (i=4%; P/F=(0.8219+0.6756+0.5553+0.4564+0.3751+0.3083)=3.1926)				**$111,741**	
4	**INSTITUTIONAL CONTROLS**	4	LS	$5,000	**$20,000**	Access restrictions to area groundwater; Applied by Sunset, and Roy townships, Davis County, and HAFB with a cost of $5,000 for each locality; see Note 4.
5	**ALT. 1: Aeration Curtain 30 Year Present Worth Cost (Items 1+2+3+4)**				**$6,271,000**	
6	**-30%/+50% of the 30 Year Present Worth Cost Ranges from**			**$4,389,700**	**to**	**$9,406,500**

Notes:

1. For an FS, which represents 0%-10% design completion, a rule-of-thumb scope contingency of 10%-30% is used for vertical barriers (the lower 10% for minimal changes in project scope during design; a higher percentage of 30% indicates an opinion that the project scope may change considerably between FS and final design). Assumed a higher scope contingency of 20% for the Aeration Curtain, based on engineering judgment that additional data procured between FS and final design may add significant scope changes (Reference: Exhibit 5-6, "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," July 2000, EPA 540-R-00-002).
2. Reference: "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," July 2000, EPA 540-R-00-002.

Exhibit 5-8: Rule-of-thumb Percentages for Professional/Technical Services Capital Costs

Range of Capital Costs	<100K (%)	100K-$500K (%)	500K-$2M (%)	2M-$10M (%)
Project Management	10	8	6	5
Remedial Design	20	15	12	8
Construction Management	15	10	8	6

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project Management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), legal services outside of institutional controls (e.g., licensing).

Remedial design applies to capital cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey of design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases.

Construction management applied to capital cost and includes services to manage construction or installation of the remedial action, except any similar services provided as part of regular construction activities. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings.

For the aeration curtain whose capital costs fall within 500K-$2M range, the rule-of-thumb percentages for Project Management and Remedial Design are 6% and 12%, respectively. Also, the construction management allocation is 6% of capital costs (for labor), which excludes 1% for Site Security and 1% for Traffic Management.

3. Site security and traffic management are considered a part of construction management and oversight; they are itemized separately as the construction is located in the midst of a residential area.
4. Institutional controls are non-engineering or legal/administrative measures to reduce or minimize the potential for exposure to site contamination or hazards by limiting or restricting site access. These controls could include institutional control plans, restrictive covenants, property easements, zoning, deed notices, advisories, groundwater use restrictions, and site information database as referenced in EPA 540-R-00-002.

TABLE C-2

ALTERNATIVE 2: SLURRY WALL AND EXTRACTION TRENCH
EE/CA FOR OU 12
HILL AIR FORCE BASE, UTAH
(Page 1 of 3)

Item No.	Item / Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
1	**DIRECT CAPITAL COSTS**					
	Slurry Wall and Extraction Trench - 660 ft long and 30 ft deep					
	Mobilization/Demobilization	1	LS	$40,000	$40,000	DeWind Environmental quotation
	Furnish and install Extraction Trench (18 in wide)	660	LF	$200	$132,000	DeWind Environmental quotation; furnish and install extraction trench with 4-inch diameter HDPE screen 30 feet bgs; pea gravel and HDPE screen included.
	Furnish and Install 4-ft diameter concrete sump to 35-ft bgs	1	LS	$40,000	$40,000	DeWind Environmental quotation
	Furnish and Install Slurry Wall (29 in wide) up to 30-ft bgs	660	LF	$120	$79,200	DeWind Environmental quotation
	Haul Extraction Trench spoils to SMS at Hill AFB (only if fails screening criteria)	1,100	CY	$20	$22,000	660 ftx 30 ftx 1.5 ft; includes loading, unloading, and spreading costs at the SMS and later pickup and dump at Hill AFB landfill
	Extraction Equipment					
	Submersible Pumps for Sump	2	each	$7,000	$14,000	Estimate for a Ingersoll-Dresser pump from Delco Western for 30-35 gpm @ TDH of 60-70 feet. Includes VFD for each pump.
	Flow Meter for Sump	2	each	$2,500	$5,000	Bailey, Fischer & Porter, series 3000, 0-30 gpm, flanged. Includes 1 spare.
	Extraction Equipment Installation Cost	50%	Equipment Costs	$19,000	$9,500	Engineering estimate
	NDCSD Permit					
	Obtain permit for discharging of extracted groundwater to sanitary sewer	1	LS	$5,000	$5,000	Engineering estimate
	Monitoring Well Installation					
	12 Monitoring wells and 12 piezometers (2.5"dia, 30 ft deep)	24	Monitoring Well	$4,800	$115,200	Lump sum price includes PVC riser pipe, PVC screen, well development, vault box installation and disposal of IDW
	Pressure Transducers for 12 Piezometers and 6 Monitoring Wells	18	each	$600	$10,800	Druck pressure sensor Model PTX 1230 series, 0-30 ft of water,4-20 mA output, includes 3 ft of cable.
	Cable for Pressure Transducers	630	LF	$3	$1,890	Assumes 35 ft of additional cable per probe
	Utility Disruption					
	Water, Sewer, Gas, Power, Telephone, Cable, etc.	2	Households	$0	$0	Not Applicable
	Fiber Optic Cable	1	LS	$25,000	$25,000	Relocation costs for the fiber optic cable line running parallel to the proposed system location; Engineering estimate includes 3Com charge of $18,000
	Site Restoration	1	LS	$3,000	$3,000	Lawn replacement estimate
	Characterization Sampling and Analysis					
	Baseline sampling of groundwater around the Containment System for TCE and water quality parameters	1	LS	$12,582	$12,582	12 wells sampled once for VOCs and water quality parameters; $7,582 for sampling, analysis, data validation; $5,000 for ERPIMS deliverable.
	Process Building					
	Treatment Building - residential appearance (inclusive of Civil, Mechanical and Electrical Components)	1	LS	$373,000	$373,000	Based on OU 12 Base Boundary Containment System/ OU 5 Phase III location
	System Prove Out/ Optimization	48	hrs	$70	$3,360	Engineering estimate; one operator at full-time for one week @ $70/hr and 20% labor oversight
	Scope Contingency					
	Contingency Costs	15%	Capital Costs	$891,532	$133,730	See Note 1
	Subtotal Capital Costs				**$1,025,262**	

TABLE C-2

ALTERNATIVE 2: SLURRY WALL AND EXTRACTION TRENCH
EE/CA FOR OU 12
HILL AIR FORCE BASE, UTAH
(Page 2 of 3)

Item No.	Item Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
	Project Management (Hill AFB)	6%	Capital Costs	$1,025,262	$61,516	See Note 2
	Remedial Design	12%	Capital Costs	$1,025,262	$123,031	See Note 2
	Construction Management/Oversight	6%	Capital Costs	$1,025,262	$61,516	See Note 2
	Site Security	1%	Capital Costs	$1,025,262	$10,253	See Note 3
	Traffic Management Plan	1%	Capital Costs	$1,025,262	$10,253	See Note 3
	Subcontractor Installation Costs				**$266,568**	
	Remedial Action Contractor (RAC) Administrative Costs	10%	Capital Costs	$1,025,262	$102,526	Engineering estimate based on previous Hill AFB projects
	Profit	8%	Capital & Installation Costs	$1,291,830	$103,346	Engineering estimate based on previous Hill AFB projects
	Subcontractor Mark-up & Profit				**$205,873**	
	TOTAL DIRECT COSTS				**$1,497,702**	Inclusive of subcontractor mark-up (10%) and profit (8%).
2	**ANNUAL COSTS**					
	Annual Monitoring Costs of Performance Monitoring Wells					
	Annual monitoring of 12 wells for VOCs and field parameters	1	/Yr	$12,582	$12,582	12 wells sampled once for VOCs and water quality parameters; $7,582 for sampling, analysis, data validation; $5,000 for ERPIMS deliverable.
	Analytical Data Report	1	/Yr	$20,000	$20,000	From OU 5
	Well/Vault Replacement Costs	1	LS	$5,000	$5,000	Assumed average annual expenditure for monitoring well and/or vault replacement at the rate of one well per year.
	Annual O&M of Containment System					
	Electrical Requirements	130,699	kW-hr	$0.07	$9,149	Approximately 20 HP around the year
	Subcontractor O&M Charges	1	/Yr	$36,000	$36,000	Estimate $3,000 per month for weekly visits by a operator and additional emergency visits
	Quarterly monitoring of discharge to the sanitary sewer	4	/Yr	$3,000	$12,000	Quarterly sampling for VOCs, metals, flow, etc.; Inclusive of sampling labor
	Fee for discharging 33 gpm groundwater to sanitary sewer	17,345	1000 Gallons	$0.60	$10,407	Fee currently charged by North Davis County Sewer District
	TSOR for Containment System	1	/Yr	$30,000	$30,000	TSOR - treatment system operation report
	Lease Agreement for the Railroad Corridor Site	1	LS	$0	$0	Not Applicable
	Lease City-Owned Site for locating the treatment building	1	Year	$6,000	$6,000	Engineering estimate
			SUBTOTAL ANNUAL COSTS		**$141,138**	
	30-YEAR PRESENT WORTH OF ANNUAL COSTS (i=4%;n=30,P/A=17.2920)				**$2,440,555**	
3	**SUMMARY REPORT (Every 5 Years)**	1	/5 Yrs	$35,000		
	30-YEAR PRESENT WORTH (i=4%; P/F=(0.8219+0.6756+0.5553+0.4564+0.3751+0.3083)=3.1926)				**$111,741**	
4	**INSTITUTIONAL CONTROLS**	4	LS	$5,000	**$20,000**	Access restrictions; Applied by Sunset, and Roy townships, Davis County, and HAFB with a cost of $5,000 for each locality; see Note 4.
5	**ALT. 2: Slurry Wall & Extraction Trench 30 Year Present Worth Cost (Items 1+2+3+4)**				**$4,070,000**	
6	**-30%/+50% of the 30 Year Present Worth Cost Ranges from**			**$2,849,000**	**to**	**$6,105,000**

Notes:

1. For an FS, which represents 0%-10% design completion, a rule-of-thumb scope contingency of 10%-30% is used for vertical barriers (the lower 10% for minimal changes in project scope during design; a higher percentage, say 30%, indicates an opinion that the project scope may change considerably between FS and final design). Assumed a slightly higher scope contingency of 15% for the Slurry Wall and Extraction Trench, based on engineering judgment. (Reference: Exhibit 5-6, "A Guide to Developing and Documenting Cost

TABLE C-2

ALTERNATIVE 2: SLURRY WALL AND EXTRACTION TRENCH
EE/CA FOR OU 12
HILL AIR FORCE BASE, UTAH

Item No.	Item	Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment

Estimates During the Feasibility Study," July 2000, EPA 540-R-00-002).

2. Reference: "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," July 2000, EPA 540-R-00-002.

Exhibit 5-8: Rule-of-thumb Percentages for Professional/Technical Services Capital Costs

Range of Capital Costs	**<100K (%)**	**100K-$500K (%)**	**500K-$2M (%)**	**2M-$10M (%)**
Project Management	10	8	6	5
Remedial Design	20	15	12	8
Construction Management	15	10	8	6

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project Management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), legal services outside of institutional controls (e.g., licensing).

Remedial design applies to capital cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey of design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases.

Construction management applied to capital cost and includes services to manage construction or installation of the remedial action, except any similar services provided as part of regular construction activities. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings.

For the Slurry Wall & Extraction Trench, whose capital costs fall within 500K-$2M range, the rule-of-thumb percentages for Project Management and Remedial Design are 6% and 12%, respectively. Also, the construction management allocation is 6% of capital costs (for labor), which excludes 1% for Site Security and 1% for Traffic Management.

3. Site security and traffic management are considered a part of construction management and oversight; they are itemized separately as the construction is located in the midst of a residential area.

4. Institutional controls are non-engineering or legal/administrative measures to reduce or minimize the potential for exposure to site contamination or hazards by limiting or restricting site access. These controls could include institutional control plans, restrictive covenants, property easements, zoning, deed notices, advisories, groundwater use restrictions, and site information database as referenced in EPA 540-R-00-002.

TABLE C-3

ALTERNATIVE 3: PRB WALL
EE/CA FOR OU 12
HILL Air Force Base, UTAH
(Page 1 of 3)

Item No.	Item	Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
1	**DIRECT CAPITAL COSTS**						
PRB - 660 ft long, 18 inches wide and 30 ft deep							
	Mobilization/Demobilization of Single Pass Trencher		1	LS	$60,000	$60,000	DeWind Environmental quotation
	Trencher		660	LF	$300	$198,000	DeWind Environmental quotation; one-pass trench to 30 feet depth with automatic backfill with Iron/sand mix
	Iron Filings (PMP Cast Iron Aggregate ETI 8/50) for the PRB		948	tons	$450	$426,576	Includes shipping by flatbed trucks in 3,000 lb supersacks from Michigan to Ogden, Utah
	Washed Concrete Sand for the PRB		983	tons	$67	$65,854	Provided by Dewind; Includes labor for mixing and delivering the sand/iron mix to the trencher
	Trucking of trencher spoils to SMS at Hill AFB (only if fails screening criteria)		1063	CY	$20	$21,267	660 ft x (30-1) ft x 1.5 ft; includes loading, unloading, and spreading costs at the SMS and later pickup and dump at Hill AFB landfill
Monitoring Well Installation							
	16 Monitoring wells (2.5"dia, 30 ft deep)		16	Monitoring Well	$4,800	$76,800	Lump sum price includes PVC riser pipe, PVC screen, well development, vault box installation and disposal of IDW
Utility Disruption							
	Water, Sewer, Gas, Power, Telephone, Cable, etc.		2	Households	$0	$0	Not Applicable
	Fiber Optic Cable		1	LS	$25,000	$25,000	Relocation costs for the fiber optic cable line running parallel to the proposed system location; Engineering estimate includes 3Com charge of $18,000
Site Restoration			1	LS	$3,000	$3,000	Lawn replacement estimate
Characterization Sampling and Analysis							
	Baseline sampling of groundwater around the PRB for TCE and water quality parameters		1	LS	$15,109	$15,109	16 wells sampled once for VOCs and water quality parameters; $10,109 for sampling, analysis, data validation; $5,000 for ERPIMS deliverable.
Scope Contingency							
	Contingency Costs		10%	Capital Costs	$891,605	$89,161	See Note 1
		Subtotal Capital Costs				**$980,766**	
	Project Management (Hill AFB)		6%	Capital Costs	$980,766	$58,846	See Note 2
	Remedial Design		12%	Capital Costs	$980,766	$117,692	See Note 2
	Construction Management/Oversight		6%	Capital Costs	$980,766	$58,846	See Note 2
	Site Security		1%	Capital Costs	$980,766	$9,808	See Note 3
	Traffic Management Plan		1%	Capital Costs	$980,766	$9,808	See Note 3
	Environmental Patent Fee (one-time)		12%	PRB Construction Costs	$750,429	$90,052	See Note 4
		Subcontractor Installation Costs				**$345,051**	

TABLE C-3

ALTERNATIVE 3: PRB WALL
EE/CA FOR OU 12
HILL Air Force Base, UTAH
(Page 2 of 3)

Item No.	Item	Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment
	Remedial Action Contractor (RAC) Administrative Costs		10%	Capital Costs	$980,766	$98,077	Engineering estimate based on previous Hill AFB projects
	Profit		8%	Capital & Installation Costs	$1,325,816	$106,065	Engineering estimate based on previous Hill AFB projects
		Subcontractor Mark-up & Profit				**$204,142**	
	TOTAL DIRECT COSTS					**$1,529,958**	Inclusive of subcontractor mark-up (10%) and profit (8%).
2	**ANNUAL COSTS**						
	Annual Monitoring Costs of Performance Monitoring Wells						
	Annual monitoring of 16 wells for VOCs and field parameters		1	/Yr	$15,109	$15,109	16 wells sampled for VOCs and water quality parameters; $10,109 for sampling, analysis, data validation; $5,000 for ERPIMS deliverable.
	Analytical Data Report		1	/Yr	$20,000	$20,000	From OU 5
	Well/Vault Replacement Costs		1	LS	$5,000	$5,000	Assumed average annual expenditure for monitoring well and/or vault replacement at the rate of one well per year.
	Lease Agreement for the Railroad Corridor Site		1	LS	$0	$0	Not Applicable
			SUBTOTAL ANNUAL COSTS			**$40,109**	
	30-YEAR PRESENT WORTH OF ANNUAL COSTS (i=4%;n=30,P/A=17.2920)					**$693,565**	
3	**SUMMARY REPORT (Every 5 Years)**		1	/5 Yrs	$35,000		
	30-YEAR PRESENT WORTH (i=4%; P/F=(0.8219+0.6756+0.5553+0.4564+0.3751+0.3083)=3.19)					**$111,741**	
4	**INSTITUTIONAL CONTROLS**		4	LS	$5,000	**$20,000**	Access restrictions; Applied by Sunset, and Roy townships, Davis County, and HAFB with a cost of $5,000 for each locality; see Note 5.
5	**ALT. 3: PRB WALL 30 Year Present Worth Cost (Items 1+2+3+4)**					**$2,356,000**	
6	**-30%/+50% of the 30 Year Present Worth Cost Ranges from**				**$1,649,200**	**to**	**$3,534,000**

Notes:

1. For an FS, which represents 0%-10% design completion, a rule-of-thumb scope contingency of 10%-30% is used for vertical barriers (the lower 10% for minimal changes in project scope during design; a higher percentage, say 30%, indicates an opinion that the project scope may change considerably between FS and final design). Assumed a lower scope contingency of 10% for the PRB Wall based on engineering judgment. (Reference: Exhibit 5-6, "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," July 2000, EPA 540-R-00-002).
2. Reference: "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," July 2000, EPA 540-R-00-002.

Exhibit 5-8: Rule-of-thumb Percentages for Professional/Technical Services Capital Costs

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TABLE C-3

ALTERNATIVE 3: PRB WALL
EE/CA FOR OU 12
HILL Air Force Base, UTAH
(Page 3 of 3)

Item No.	Item	Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)	Comment

For the PRB Wall whose capital costs fall within 500K-$2M range, the rule-of-thumb percentages for Project Management and Remedial Design are 6% and 12%, respectively. Also, the construction management allocation is 6% of capital costs (for labor), which excludes 1% for Site Security and 1% for Traffic Management.

3. Site security and traffic management are considered a part of construction management and oversight; they are itemized separately as the construction is located in the midst of a residential area.
4. Environmental Patent Fee - Envirometal currently receives a 12% patent fee for the use of the PRB technology on DOD projects. Fee is based on the PRB material construction costs and the installation cost (single pass trencher). Labor for construction management is not included in this fee.
5. Institutional controls are non-engineering or legal/administrative measures to reduce or minimize the potential for exposure to site contamination or hazards by limiting or restricting site access. These controls could include institutional control plans, restrictive covenants, property easements, zoning, deed notices, advisories, groundwater use and site information database as referenced in EPA 540-R-00-002.